

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

A43, 9
R312
Copy 2

UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

ANIMAL HUSBANDRY RESEARCH DIVISION

and

COOPERATING WESTERN STATES

W-1 - IMPROVEMENT OF BEEF CATTLE THROUGH THE APPLICATION OF
BREEDING METHODS

1967 Annual Report of W-1

and

Report of

Annual Meeting of Technical Committee

August 4 and 5, 1967
Reno, Nevada

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

MAY 20 1968

CURRENT SERIAL RECORDS

This report is intended for the use of administrative leaders
and workers and is NOT for general distribution

1967

Annual Report of W-1

and

Report of

Annual Meeting of Technical Committee

Reno, Nevada

August 4 and 5, 1967



CONTENTS

Agenda	i
Personnel	ii
Welcome	1
D. W. Bohmont, Nevada Agricultural Experiment Station	
Station Reports	
Arizona	2
California	9
California - Bovine Achondroplasia	15
Colorado	20
Colorado - Lipid Project	25
Hawaii7	35
Idaho	41
Montana	45
U. S. Range Livestock Experiment Station	54
Nevada	73
New Mexico	81
Oregon	85
Utah	98
Washington	102
Wyoming	105
Project Reports and Discussions.....	111
Efficiency of Feed Utilization	131
J. H. Meyer, University of California, Davis	
Improvement in Beef Production Efficiency Through Selection for Body Composition	132
Gerald M. Ward, Colorado State University	
Project Revisions	141
Comments of Administrators	153
Time and Place of Next Meeting	157
Resolutions	158

CHAPTER I

THE HISTORY OF

THE UNITED STATES OF AMERICA

FROM 1776 TO 1876

BY

JOHN B. HENNINGSEN

OF THE UNIVERSITY OF CHICAGO

AND

OF THE UNIVERSITY OF CALIFORNIA

AND

OF THE UNIVERSITY OF MICHIGAN

AND

OF THE UNIVERSITY OF ILLINOIS

AND

OF THE UNIVERSITY OF WISCONSIN

AND

OF THE UNIVERSITY OF MINNESOTA

AND

OF THE UNIVERSITY OF NEBRASKA

AND

OF THE UNIVERSITY OF KANSAS

AND

OF THE UNIVERSITY OF OKLAHOMA

AND

OF THE UNIVERSITY OF TEXAS

AND

OF THE UNIVERSITY OF ARIZONA

AND

OF THE UNIVERSITY OF CALIFORNIA

AGENDA

W-1 Technical Committee Meeting

University of Nevada

Reno, Nevada

August 4 and 5, 1967

Estel H. Cobb, Chairman

Friday

8:00 A.M. Welcome

Dr. D. W. Bohmont, Director

Nevada Agricultural Experiment Station

8:30 A.M. Station Reports

Arizona, California, Colorado, Hawaii, Idaho, Montana,
U. S. Range Livestock Experiment Station, Nevada, New
Mexico, Oregon, Utah, Washington, and Wyoming

1:30 P.M. Efficiency of Feed Utilization

Dr. J. H. Meyer, Associate Director

California Agricultural Experiment Station, Davis

Some Thoughts on Selection for Body Composition

Dr. G. M. Ward, Professor, Animal Nutrition

Colorado State University

3:00 P.M. Tour of Main Station and Field Laboratory

Saturday

8:30 A.M. Project Revisions and Supplements

Arizona, Montana, New Mexico, and Utah

Discussion of Regional Bulletin

Business Meeting

Comments

J. H. Meyer, Administrative Adviser, W-1

E. J. Warwick, Chief, Beef Cattle Research Branch

R. H. Carter, representing Cooperative State Research
Service

Bradford W. Knapp, Acting Investigations Leader

PERSONNEL

Project Leaders

Carl B. Roubicek*	Arizona
W. C. Rollins*	California
J. S. Brinks*	Colorado
E. H. Cobb*	Hawaii
R. E. Christian*	Idaho
R. L. Blackwell*	Montana
C. M. Bailey*	Nevada
L. A. Holland*	New Mexico
Ralph Bogart*	Oregon
J. A. Bennett*	Utah
J. K. Hillers**	Washington
P. O. Stratton*°	Wyoming
O. F. Pahnish*	U. S. Range Livestock Experiment Station

Administrative Adviser

J. H. Meyer	California
-------------	------------

Agricultural Research Service

Bradford W. Knapp	Acting Investigations Leader
E. J. Warwick	Chief, Beef Cattle Research Branch

Cooperative State Research Service, represented by

R. C. Carter	Virginia
--------------	----------

Guests Present

Donald E. Ray	University of Arizona
D. A. Cramer	Colorado State University
G. M. Ward	Colorado State University
Diedrich Reimer	University of Hawaii
R. E. Ely	University of Nevada
V. R. Bohman	University of Nevada
W. C. Behrens	University of Nevada
C. R. Torell	University of Nevada
S. P. Hammack	University of Nevada
Larry V. Cundiff	Investigations Leader, NC-1
Gary V. Richardson	Agricultural Research Service Biometrical Services

*Voting members

**Representing C. C. O'Mary

*°Representing G. E. Nelms

General Remarks

The following table gives a summary of the results of the experiments conducted during the last year. The first column shows the date of the experiment, the second column the name of the person who conducted it, and the third column the results obtained.

Summary of Results

The results of the experiments conducted during the last year are summarized in the following table.

Conclusions

The results of the experiments conducted during the last year lead to the following conclusions:

Conclusions (continued)

The results of the experiments conducted during the last year lead to the following conclusions:

Conclusions (continued)

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

The results of the experiments conducted during the last year lead to the following conclusions:

References

The following references are given for the experiments conducted during the last year:

W-1 Technical Committee Meeting

University of Nevada
Reno, Nevada
August 4 and 5, 1967

Estel H. Cobb, Chairman

The W-1 Technical Committee convened at 8:00 A. M. in the Conference Room of Fleischmann Agriculture Building. The meeting was called to order by the chairman, Dr. Cobb, who introduced Dr. Bohmont, Director of the Nevada Agricultural Experiment Station.

Dr. Bohmont:

Since you people have been here all week attending the meetings of the American Society of Animal Science, it is not appropriate that we "welcome" you. But you are most welcome.

Nevada is the 7th state in the nation in area. In earnings in the nation we would like to place higher than we do. The station would be better off if we did.

The topography of the state is interesting. We have 100 drainage basins. Many are being irrigated. Pump irrigation is going on throughout the state. We have stations where wells draw down to about 100 feet on land where the pioneers wondered where their next drink was coming from.

We as a state have grown rapidly--most rapidly in the nation.

Reno is a recreation area. We enjoy it. We hope you do, too. And we hope you have a very productive conference here.

UNIVERSITY OF ARIZONA

- I. Station: Arizona Agricultural Experiment Station
- II. Project title: 1. Breeding and selection of beef cattle for the Southwest. 2. Progeny testing of selected Hereford sires.
- III. Personnel:

Experiment Station:

C. B. Roubicek, Project Leader, D. E. Ray, L. W. Dewhirst,
A. M. Lane, and B. R. Taylor

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

IV. Nature and extent of work done this year:

1. The third breeding season of the line test program proceeded on schedule.
2. The analyses of blood and liver data were completed.
3. The first year of bull progeny performance on feed test was completed.
4. Analysis of top cross cow performance data is completed and is now being summarized.

V. Progress summary:

1. Individual test performance of progeny bull calves is shown in table 1. The ration was a 60 percent total digestible nutrient mixture:

Steam-processed milo	350 lb.
Steam-processed barley	350 lb.
Ground alfalfa hay	200 lb.
Cottonseed pellets	240 lb.
Cottonseed hulls	710 lb.
Molasses	140 lb.
Dicalcium phosphate	5 lb.
Salt	5 lb.
	2,000 lb.
CCC trace mineral premix	1 lb.

The correlation of initial weight and total gain:

$$r = +.067$$

$$b = +.044$$

Table 1. Performance of Test Bulls
1966-67

Sire	Progeny	Initial weight					Average					Score
		11/21	28	56	84	112	140	Total gain	lb.	lb.	lb.	
		lb.	days	days	days	days	days	gain	lb.	lb.	lb.	
062 - Havre H 791	321	515	626	714	772	882	970	455	3.25			12/13
	245	614	712	832	948	1040	1110	496	3.54			13/13
	277	534	644	744	818	872	932	398	2.84			11/13
087 - Bozeman 114	264	556	678	778	882	964	1027	471	3.36			13/13
	197	513	608	704	778	854	915	402	2.87			11/12
	253	501	644	712	806	880	977	476	3.40			11/12
	52	570	670	774	870	940	990	420	3.00			12/13
	33	538	636	720	810	844	896	353	2.56			11/13
	156	517	520	570	644	724	802	285	2.04			11/13
	369	370	418	518	602	692	783	413	2.95			12/12
088 - Brae Arden 9068	244	496	576	658	740	820	920	424	3.03			11/13
	162	609	682	746	808	872	937	328	2.34			13/12
	351	474	550	616	720	804	874	400	2.86			12/13
	26	533	618	722	800	874	964	431	3.08			12/14
	176	579	682	776	844	900	941	362	2.59			12/13
	285	481	552	644	738	830	904	423	3.02			12/13
	157	475	556	650	728	814	883	408	2.91			10/13
089 - Royal 0006	286	524	610	704	800	908	976	452	3.23			11/14
	305	485	--	--	--	---	--	--	--			--
	365	466	560	656	762	866	954	488	3.49			11/13
	338	460	550	604	702	792	846	386	2.76			10/13
	379	380	472	564	660	734	821	441	3.15			10/14
	209	501	570	664	734	814	906	405	2.89			11/14

(Continued)

Table 1. Performance of Test Bulls
1966-67

(Continued)

Sire	Progeny	Initial weight		28 days		56 days		84 days		112 days		140 days		Average		Score
		11/21	lb.	12/19	lb.	1/16	lb.	2/13	lb.	3/13	lb.	4/10	lb.	Total gain	daily gain	
090 - L 14 1423		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	
	210	527	624	712	822	920	1000	473	3.38	13/12						
	180	562	684	780	840	970	1089	527	3.76	13/13						
	93	649	712	794	888	964	1027	378	2.70	13/13						
	70	492	532	630	730	824	933	441	3.15	12/13						
	87	535	604	704	758	854	930	395	2.82	12/14						
091 - L 4 9250	6	586	690	792	862	880	965	379	2.71	11/13						
	282	575	680	782	894	972	1031	456	3.26	11/13						
	218	456	548	644	730	820	922	466	3.33	12/13						
	205	539	660	720	810	892	976	437	3.12	12/13						
	181	458	524	622	740	812	878	420	3.00	12/14						
	229	552	692	792	880	982	1056	504	3.60	13/13						
092 - Utah 0119	114	580	684	790	882	950	995	415	2.96	12/13						
	184	451	500	586	666	764	834	383	2.74	12/12						
	278	495	596	684	774	864	922	427	3.05	12/13						
	291	497	544	640	720	808	874	377	2.69	11/13						
	37	355	424	500	560	604	674	319	2.28	10/12						
	295	496	583	690	784	844	929	433	3.09	12/13						
	299	487	524	624	724	782	--	--	--	--						
093 - Wyoming 71	23 ¹	547	660	752	824	890	930	383	2.74	11/11						
	251	529	608	650	720	784	834	305	2.18	10/13						
	65	527	618	728	826	922	997	470	3.35	12/13						
	77 ¹	535	636	736	840	886	921	386	2.76	11/13						

1Bloaters

(Continued)

Table 1. Performance of Test Bulls
1966-67

	Progeny	Initial weight		28 days		56 days		84 days		112 days		140 days		Average		Score
		11/21	lb.	12/19	days	1/16	days	2/13	days	3/13	days	4/10	days	Total gain	lb.	
096 - New Mexico 100	919	312	376	435	524	626	727	415	2.96	9/12						
	562	354	456	560	660	748	847	493	3.52	10/13						
	810	402	504	580	648	724	809	407	2.91	11/12						
	839	245	306	364	466	550	621	375	2.68	9/10						
097 - Nevada 722	819	339	396	472	578	680	744	405	2.89	9/12						
	528	420	515	622	716	790	857	437	3.12	10/13						
	534	530	610	722	794	900	968	438	3.13	10/12						
	834	376	458	538	626	690	731	355	2.54	9/11						
	501	421	532	630	712	810	868	447	3.19	10/13						
	635	444	524	636	720	816	902	458	3.27	10/14						
080 - Texas 098	661	490	570	638	730	808	837	347	2.48	10/14						
084 - Colorado 30	3	446	544	630	706	770	824	378	2.70	12/13						
	296	469	554	638	704	770	824	355	2.54	11/13						
	234	444	514	600	684	782	862	418	2.99	12/14						
	104	540	592	718	808	912	972	432	3.09	11/14						
	238	496	590	604	690	780	850	354	2.53	11/14						
	346	502	590	700	796	890	973	471	3.36	12/13						
094 - University of Arizona	46	591	700	800	886	982	1070	479	3.42	12/14						
	131	443	544	636	722	824	890	447	3.19	12/14						
	85	519	562	652	674	774	843	324	2.31	11/13						
	175	505	606	690	756	800	886	381	2.72	12/14						
	149	585	682	786	878	944	1021	436	3.11	12/14						
1Bloater	35	589	682	774	840	930	968	379	2.71	13/13						

(Continued)

lbloater

Initial and final weight, average of two days.

Score: Conformation/condition. 10 = low choice, 15 = top score.

(Continued)

Table 1. Summary of Progeny Performance Test Bulls
1966-67

(Continued)

Sire	Number	Initial weight	Final weight	140-day average daily gain
		lb.	lb.	lb.
062 - Havre H 791	3	554	1004	3.21
087 - Bozeman 114	7	509	913	2.89
088 - Brae Arden 9068	7	521	918	2.84
089 - Royal 0006	5	466	901	3.11
090 - L 14 1423	6	559	991	3.09
091 - L 4 9250	5	516	973	3.26
092 - Utah 0119	6	479	871	2.80
093 - Wyoming 71	4	535	921	2.76
096 - New Mexico 100	4	329	751	3.01
097 - Nevada 722	6	422	845	3.02
084 - Colorado 30	6	483	884	2.86
094 - University of Arizona	6	539	946	2.91
Mean		494	909	2.97

Feed conversion = 7.34

2. A summary of heritability estimates of some blood and liver constituents show a sex and season effect for some of the constituents.

Table 2. Heritability Estimates
Unsupplemented Range Herefords

Sex	Hepatic carotene	Hepatic A	Hemoglobin	Plasma carotene	Plasma A	Plasma P
<u>Males</u>						
Weaning	0.14	0.36	0.22	0.43	0.19	0.03
12 mo.	0.02	0.03	0.04	0.13	--	0.10
20 mo.	0.12	0.79	0.25	1.06	0.17	0.13
24 mo.	0.20	0.48	0.16	0.50	--	0.32
<u>Females</u>						
Weaning	0.36	0.77	0.27	0.28	0.16	0.04
12 mo.	0.70	0.38	0.10	0.16	0.13	0.08
20 mo.	0.52	0.76	0.30	0.27	--	--
24 mo.	0.26	0.29	0.20	0.22	0.04	0.03

Summary of Individual Data on Regional Bulls Used at Arizona During the 1967 Breeding Season

Name and origin of bull	Tattoo and registra- tion number	Birth weight Act.Dev.	Weaning weight Act. Dev.	Adjusted		Daily gain on test Act. Dev.	Feed efficiency Act.	Days on test Act.Dev.	Final		Age						
				weaning weight Act. Dev.	weight Dev.				weight off test Act. Dev.	test off test Act. Dev.							
MSC Clay's Supreme 61	347																
Bozeman, Montana	12753233	84	2	331	30	509	46	2.24	-.04	6.31 ¹	-1.52	140	0	650	-83	260	0
CL Mischief 16	3199																
Miles City, Montana	12771096	81	-5	439	60	408	53	2.87	-.05			196	0	1005	41	405	1
L14 Mixer 134	4536																
Miles City, Montana	13313219	74	-8	415	-59	415	-34	2.77	.03			196	0	1043	40	390	-12
NMSU 512	512																
New Mexico	13723917	82	5	561	14			3.01	.11	411 ²	-30	140	0	1137	13	458	1
USU Prince Lincoln	113C																
Utah	13983660	88	10	490	11	452	62	3.15	.26	21.11 ³	1.00	105	-1	873	51	416	-1
Reno E 306	716																
Nevada	12736477			465	-7	464	-15	1.89	.20	21.60 ³	2.80	140	0	740	18	386	-6
KC E 303	K-413																
Nevada	12736501			390	-36	407	-29	1.24	.13	18.80 ³	2.60	140	0	568	-27	397	7
Royal 4578	4578																
Colorado	13343265			390	5	472	31	2.46	-.27			140	0	1004	1	558	-1
Brae Arden 5410	5410																
Colorado	13671320			505	101	536	80	2.62	-.03	6.70 ¹	.41	140	0	896	44	426	9
Gillette Arden 74	74																
Wyoming	13141812	86	10	468	67	439	36	2.65	.32			168	0	915	114	372	7

¹Feed/lb. gain - lower value is superior

²TDN/100 lb. gain - lower value is superior

³Gain/cwt.TDN - higher value is superior

VIII. Publications and manuscripts:

Roubicek, C. B. 1967. Cattle records by the numbers. Prog. Agr. Ariz. 19:12-13.

Taylor, R. L., O. F. Pahnish, C. B. Roubicek and W. H. Hale. 1966. Plasma cholesterol concentration in unsupplemented range cattle. J. Anim. Sci. 25:1035-1039.

IX. Project summary:

Arizona Agricultural Experiment Station

Cattle Inventory - June 30, 1966		Total
Breed		Hereford
Purebred or grade		Purebred
Bulls (12 mo. or over)		146
Cows (2 yr. or over)		476
Heifers (yearlings)		131
Calves - bulls		188
- heifers		199

Cow Production Data - 1966 calf crop		
Number cows bred to calve:		
As 3-yr. olds and up		484
Number calves born:		
Alive		392
Dead		19
Cows died at parturition		8
Number calves weaned		387
Percent calf crop:		
Born		86.3
Weaned		81.3

Prewaning Performance - 1966 calf crop			
	bulls		heifers
Birth weight	73		68
Weaning age	250		250
Weaning weight - lb.	524		467
Weaning score:			
Condition	10		11
Conformation	10		11

UNIVERSITY OF CALIFORNIA

- I. Station: California Agricultural Experiment Station, Davis
- II. Project title: Studies of heterotic effects in crosses of the Angus, Hereford, and Shorthorn breeds
- III. Personnel:

Experiment Station:

W. C. Rollins, Project Leader, F. D. Carroll, Christopher Nwosu, Moira Tanaka, K. A. Wagnon, Jack Ziegler

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

- IV. and V. Nature and extent of work done this year and summary of progress and conclusions to date:

The experimental work has proceeded according to plan.

- A. Weaning weight and postweaning growth of third calf crop (sired by a Shorthorn bull)

Table 1. Performance Comparisons of SA and SH Crossbreds, respectively, with SS Straightbreds

			(SA-SS) x100		(SH-SS) x100
	Overall average	SA-SS	SS %	SH-SS	SS %
205-day weaning weight	356	4	1.1	-19	-5.1
Weaning grade	87	-1	-.8	-1	-1.6
Postweaning gain:					
Bulls and steers in feedlot (215 days)	529	15	3.0	88	17.1
Heifers in drylot at Davis (132 days)	243	13	6.0	55	24.9
Heifers on range (132 days)	112	22	22.8	29	30.1
Age adjusted yearling weight:					
Bulls and steers in feedlot (420 days)	917	43	4.9	84	9.6
Heifers in drylot at Davis (377 days)	592	5	0.9	58	10.1
Heifers on range (377 days)	466	34	7.5	24	5.3

Table 2. Performance Comparisons of Bulls with Steers

	Overall average	Bulls-Steers	(Bulls-Steers)x100 Steers %
205-day weaning weight	382	-13	-3.3
Weaning grade	87	0	-.4
Postweaning gain	529	38	7.4
Age adjusted yearling weight	917	49	5.5

B. Bull and steer carcass and meat sensory test data are in the process of analysis

C. Developing a meat index--for beef cattle

At Davis a meat index is being developed. Its function is to rate beef calves at weaning for the meatiness of the carcasses they will later produce after being fed out.

In two tests to date--one involving 13 bulls, the other 12 steers (all of this project), fed out to low choice grade--the meat index (M.I.) was found to be correlated 0.8 and 0.7, respectively, with the amount of nonfat in the carcass expressed as a percent of live slaughter weight. The corresponding correlations using the U. C. conformation grade were 0.3 and 0.2.

The meat index is based on rump shape and the degree of visibility of a crease in the rump formed by the juncture of the semimembranosus and semitendinosus muscles. The visibility of the crease is scored from 1 to 4 while the animal is standing and again while it is moving (table 3). The shape of the rump is scored from 1 to 4 with the rump gage (R.G.) (figure 1). By moving the R.G. from close to the viewer's eye to full arm's length some position can be found at which one of the outlines will best fit the animal's rump shape.

Through the use of statistical techniques the crease scores and the rump gage score are linearly combined in a way that maximizes the correlation of the meat index (M.I.) with the amount of nonfat in the carcass expressed as a percentage of live slaughter weight.

The idea for the meat index had its genesis in work with double muscled animals. There, a marked association of rump shape and intermuscular creases with leanness and heavy musculature of the carcass was found. Score 1 on the rump gage is typical of double muscled animals, whereas normal animals tend to fall in the range from 3 to 4.

The animals used in constructing the meat indexes given here were considered normal on the basis of their own appearances and their pedigrees.

Table 3. The Visibility of the Crease Between the Semimembranosus and the Semitendinosus Muscles

Visibility score	Animal standing	Animal moving
	CS	CM
<u>Marked</u> : Crease is markedly noticeable even to one unfamiliar with cattle	1	1
<u>Definite</u> : Crease can be seen easily by one familiar with the study, but is not marked	2	2
<u>Slight</u> : Crease can be seen only by the careful observance of one familiar with the study	3	3
<u>None</u> : No crease is visible	4	4

D. Percentage calf crop live born

Angus x Angus (AA), Angus x Hereford (AH), and Angus x Shorthorn (AS) heifers bred as two-year-olds to an Angus bull (bred at Sierra Foothills Range)

AA	AH	AS
$\frac{8}{9} \times 100 = 88.9\%$	$\frac{13}{15} \times 100 = 86.7\%$	$\frac{4}{6} \times 100 = 66.7\%$

VI. Application of findings:

If the meat index is as accurate as the initial tests suggest, and if this is a heritable trait, then the meat index should significantly improve the selection of beef cattle that will produce leaner, meatier carcasses.

VII. Work planned for the future:

The Sierra Foothill Range phase of the experiment will continue as planned.

Calf crops produced at the Sierra Foothill Range Station, in addition to their use as originally planned in this project, will also afford some of the data for further testing the accuracy of the meat index (as a predictor of the future leanness and meatiness of an animal's carcass after feeding out) and estimation of its heritability.

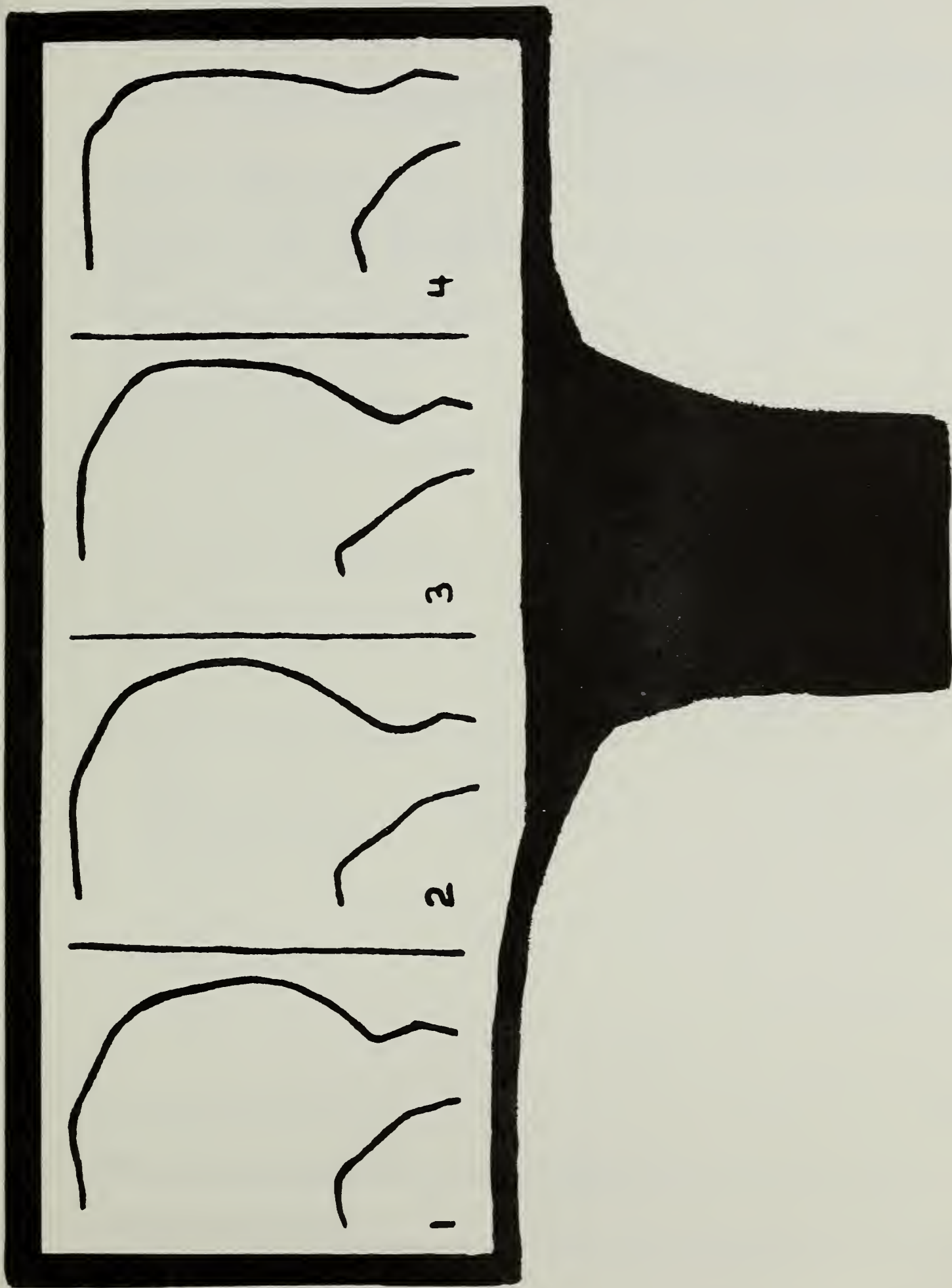


Figure 1. RUMP GAGE. Actual dimensions exclusive of handle are $8 \frac{1}{4}'' \times 3 \frac{1}{4}''$. The material is clear plexiglass.

Identification Phenotype (IP)
Variation in Thigh Creases and Rump Shape

A. Creases in thigh:

VISIBILITY

	Standing			Moving		
	I	II	III	I	I	III
None: No crease is visible						
Slight: Crease can be seen only by the careful observance of one familiar with the study						
Definite: Crease can be seen easily by one familiar with the study, but is not marked						
Marked: Crease is markedly noticeable even to one unfamiliar with cattle						

Relation of condition of coat to visibility of creases:

- _____ Obstructs
- _____ Partially obstructs
- _____ Does not obstruct

Creases I, II, and III



1. M. biceps femoris
2. M. semi-tendinosus
3. M. semi-membranosus

B. Skin thickness (double fold):

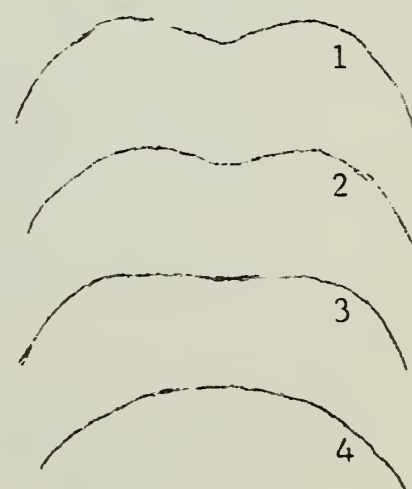
RIB
(over last rib
1/3 way down from
mid-dorsal line)

_____ mm.

THIGH:
(between creases
I and II)

_____ mm.

Gluteus Medius



C. Rump (side view)

GRADE:

1 2 3 4 fits none

Date _____ Observer _____

Animal No. and Sex _____ Breed _____

Owner _____

VIII. Publications and manuscripts:

Rollins, W. C. 1967. Developing a meat index for beef cattle. Calif. Agr. 21(5):15.

Wagnon, K. A., R. G. Loy, W.C.Rollins and F. D. Carroll. 1966. Social dominance in a herd of Angus, Hereford, and Shorthorn cows. Animal Behavior 14:474-479.

IX. Project summary:

California Agricultural Experiment Station

Cattle Inventory

Breed	AA	HH	SS	AH	AS	HA	HS	SA	SH	A(AA)	A(AH)	A(AS)
Bulls		1										
Cows												
3 yr.old	8			15	7							
Heifers												
2 yr.old		8				9	5					
Yearlings												
Bulls			3					4	6			
Steers			3					3	6			
Heifers			5					9	4			
Calves										8	13	4

A = Angus, H = Hereford, S = Shorthorn
Breed of sire shown first

Special Report
CALIFORNIA AGRICULTURAL EXPERIMENT STATION PROJECT 1451
THE GENETICS AND BIOLOGY OF BOVINE ACHONDROPLASIA
(formerly cooperative with W-1)

P. W. Gregory

During the year a comprehensive report was published presenting evidence that all types of achondroplasia studied, whether assumed to be dominant or recessive, are genetically related and are components of the same genetic complex. This is illustrated by figures 1 and 2, reproduced from the paper. (Gregory, P. W., W. S. Tyler, and L. M. Julian. Bovine Achondroplasia: The Reconstitution of the Dexter Components from Non-Dexter Stocks. Growth 30:393:418.)

This study is summarized as follows:

During the past 16 years many achondroplastic mutants, some recessive, others dominant, were studied under controlled laboratory conditions to determine how each specific mutant is interrelated genetically and morphologically to both recessive and dominant stocks and to normal, if any could be identified. During the course of the study there were several segregates that resembled the commercial Dexter. A number of both sexes were mated to registered Dexters to determine whether any would produce all the Dexter components--"bulldog" lethal, Dexter, and Kerry types. Several animals tested produced the "bulldog" and were positive for one or more of the other types, proving that Dexter had been reconstituted in several different ways. A Dexter sire was mated to several types of mutants: from comprest there were reconstituted Kerry, Dexter, and short-headed dwarfs; from short-headed dwarfs there were Dexters and other segregates as yet unclassified; from the long-headed dwarf Angus there were Kerry types which were proved by mating tests. These results clearly indicate that all achondroplastic mutants, both "dominant" and recessive, are interrelated and components of the same genetic complex. The evidence indicates that the major achondroplastic-conditioning gene is recessive, not dominant, but a search for its dominant allele in all the stock, including cattle of conventional size, thus far has been negative. The accepted hypothesis of inheritance of Dexter achondroplasia is untenable.

The assumed "dominance" of Dexter, comprest, and compact, each a complex hybrid but homozygous for the same recessive achondroplastic-conditioning gene, probably arises from interaction of alleles at two other loci that are independent, which act as modifiers to the major gene and superficially simulate dominance.

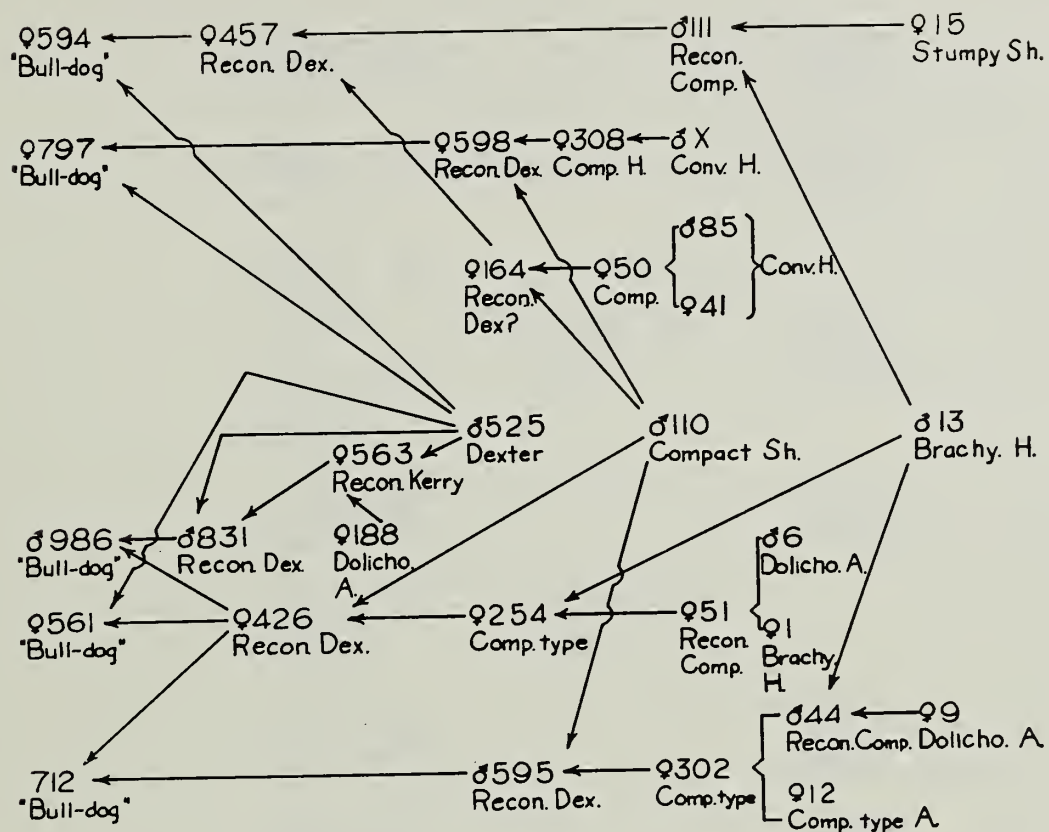


Figure 1. A pedigree network of five "bulldog" segregates that proved a number of reconstituted Dexters and the diverse means by which they may be reconstituted. Note that Dexter bull 525 mated to long-headed Angus dwarf 188 produced a reconstituted Kerry-type cow, 563, which, mated to her sire, 525, produced reconstituted Dexter bull 831 that sired two "bulldog" calves, 986 from cow 426, and 989 from cow 598 (not shown). The abbreviation "Comp." refers to comprest.

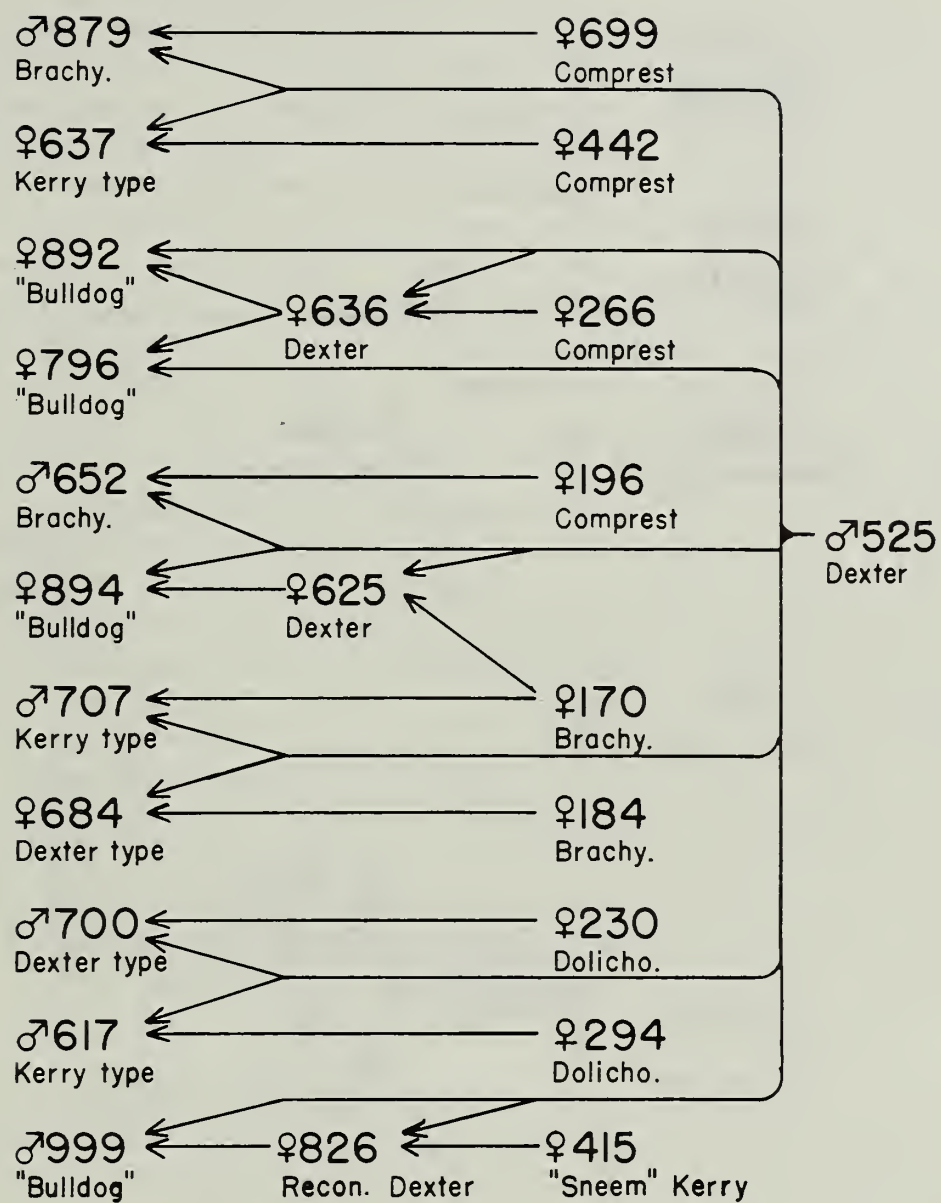


Figure 2. Pedigree network summarizing some of the results obtained from mating Dexter sire 525 to comprest, short-headed dwarfs, long-headed dwarfs, compact, and other types, illustrating the diverse micromelic types that can be produced including the Dexter components.

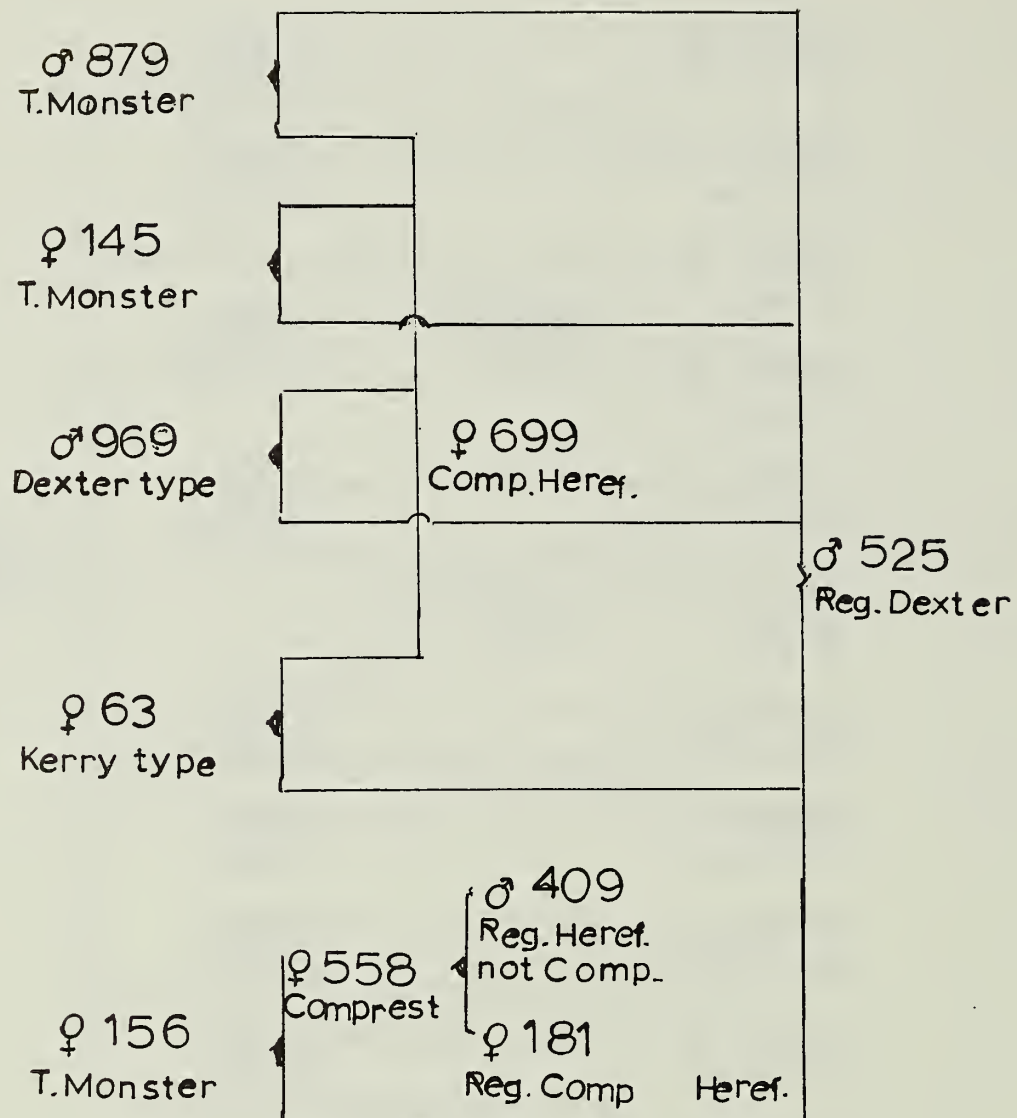


Figure 3. A pedigree network showing the results of mating a Dexter sire to comprest Hereford cows

Mating of comprest Hereford cows descended from registered Herefords to a registered Dexter bull resulted in Kerry and Dexter components and three segregates that are assumed to be identical with the Telemark lethal (Mohr, O. L., 1926. A. indukt. Abstamm. -u. Vererb-Lehre. 41.). A pedigree network showing Telemark monsters, Dexter, and Kerry types is shown in figure 3. This study is summarized from the manuscript in press.

Several specific types of achondroplastic bovine stocks were mated under laboratory conditions, but the Dexter-type segregates mated to comprest Herefords from short-headed dwarf-producing stock yielded segregates that morphologically resembled the recessive Telemark lethal of Norway in addition to Kerry and Dexter-type segregates. The Dexter-type segregates mated to registered Dexters produced bulldog calves. The Dexter, Kerry, and Telemark-like lethals were reconstituted from the mating of a Dexter sire to comprest Hereford dams. It is clear that comprest and Dexter are genetically related and, when mated, are capable of producing Kerry and Dexter components and a lethal assumed to be identical with the Telemark. There also is evidence that each of the micromelic stocks implicated is homozygous for the same major recessive achondroplastic-conditioning gene, but another pair of alleles present in Dexter and comprest parents act as modifiers and it is their segregation and interaction that seem to be responsible for the Kerry, Dexter, and bulldog lethal segregates in the 1:2:1 ratio when Dexters are mated. The results obtained at this laboratory are comparable, if not identical, to the progeny that Punnett reported from mating a Telemark sire, a proven carrier of the Telemark lethal, to Dexter cows. Several of the F₁ Dexter-type progeny were proved by progeny test to produce bulldog calves, thus meeting the requirements of the Dexter. Their conclusion that Dexter and Telemark achondroplasia are unrelated is inconsistent with their data.

At present we are putting into manuscript form the results obtained from reciprocally mating short-headed and long-headed dwarfs. In addition, there is a sizable F₂ progeny and F₁ progeny backcrossed to both long-headed and short-headed dwarf parents. The plan is to publish these results along with others as expediently as possible.

COLORADO STATE UNIVERSITY

- I. Station: Colorado Agricultural Experiment Station
- II. Project title: Study of selection, inbreeding, and the crossing of inbred lines within the Hereford breed (R & M 26)
- III. Personnel:
 - Experiment Station:
 - J. S. Brinks, Project Leader, Kent Riddle, William Hohenboken, and Glenn Richardson
 - U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
 - Bradford W. Knapp, Acting Investigations Leader
- IV. Nature and extent of work done this year:

The work proceeded during the year along project outlines. A three-year study on the milk and feed consumption of inbred and line-cross Hereford and outbred AI calves and a simultaneous study on the milk production of inbred and linecross Hereford first-calf heifers was concluded during this year. The data will be analyzed during the upcoming year.

Bulls from two inbred lines (Brae Arden and Royal) were provided for the regional line testing and genetic x environmental interaction studies being conducted at the San Carlos Reservation, Arizona, in cooperation with other stations participating in W-1.

Recent studies offer convincing evidence that there are high levels of hybrid vigor exhibited in bull semen characteristics and in viability of newborn calves. The structure or morphology of sperm cells is greatly affected by inbreeding and hybridizing, with the linecross bulls showing 26.5 percent heterosis over the inbreds in semen morphology score. The percent heterosis on other semen scores were 4.3 percent in concentration, 9.5 percent in vigor, and 7.4 percent in percent alive. In contrast, heritability estimates were predominantly low for semen characteristics, being 0.14 for semen quality, 0.37 for concentration, 0.13 for vigor, 0.06 for percent alive, and -.06 for morphology. Heterosis was evident in the reduction of death losses among calves. The four groups, consisting of inbred lines, linecrosses, controls, and crossbreds, showed 13.98, 7.46, 11.79, and 9.26 percent dying, respectively. The death losses among linecrosses relative to controls decreased from 11.79 percent to 7.46 percent, a reduction of 37 percent.

Comparisons of bull and heifer carcasses indicated that bulls produced leaner, trimmer carcasses with slightly larger rib-eye areas. The average fat thickness over the 12th rib of the bull carcasses was less than half that of the heifers and bulls also had less pelvic and kidney

fat. Bulls consistently yielded higher percentages of trimmed retail cuts (5% more) and 10 percent more total freezer meat, along with one percent more bone trim and nearly 10 percent less fat trim than heifer carcasses. Heifer carcasses graded higher, and taste panel evaluations showed steaks from heifers to be more flavorful, juicier, and more tender than those from bulls. Further comparisons are shown in table 1.

V. Summary of progress and conclusions to date:

Increased inbreeding has a detrimental effect on reproduction, survivability of calves, and early growth rate. Inbreeding of dam has a greater depressing effect on weaning weights of calves than inbreeding of calf, presumably through decreased milk production. The effect of inbreeding on growth rate decreases with increasing age.

Important heterotic effects have been demonstrated for reproduction, survivability of calves, and growth rate. Weaning weights of line-cross heifer and bull calves exceeded weights of inbred calves by 15 and 8 percent, respectively. Yearling linecross heifers averaged 6 percent heavier than inbred heifers.

VI. Applicating of findings:

The utilization of heterosis within a breed can be expected to increase the percent calves weaned.

VII. Work planned for the future:

Continuation of project along experimental design with increased emphasis on data analysis dealing with cow productivity. A bulletin on the history and performance of the inbred lines is planned.

VIII. Publications and manuscripts:

Harwin, G. O., J. S. Brinks and H. H. Stonaker. 1966. Genetic and environmental interactions affecting weaning weights of Hereford calves. J. Anim. Sci. 25(3):779-782.

Brinks, J. S. 1967. Field Day Report. Colorado Agricultural Experiment Station General Series 851.

Richardson, G. L., D. A. Cramer and H. H. Stonaker. 1967. Meat from bulls--how does it compare. Colorado Farm & Home Research 17(1).

Theurer, Larry, H. H. Stonaker and Kent Riddle. 1966. Influence of inbreeding, sex, and age on calf losses. (Abs.) J. Anim. Sci. 25(3):880.

Table 1. Production and Carcass Traits of Heifers and Bulls

	Heifers				Bulls			
	Group 1		Group 2		Group 3		Group 4	
	1962	1963	1963	1964	1962	1963	1963	1964
Number of animals	32	42	42	42	27	25	30	24
L.side weight-lb. ¹	281.8	265.2	265.2	254.3	297.6	207.8	302.5	296.0
Slaughter age-days	543.3	521.3	521.3	583.9	567.5	423.5	585.9	570.6
Avg.daily gain-lb.	2.55	2.13	2.13	2.23	3.23	2.57	2.84	2.25
Rib-eye area-sq.in.	12.4	11.1	11.1	11.0	13.0	10.4	11.9	11.7
Fat thickness-in. ²	0.70	0.60	0.60	0.62	0.40	0.15	0.30	0.23
Lean color ³	3.94	3.64	3.64	2.95	4.85	4.88	3.70	4.00
Marbling score ⁴	4.3	4.5	4.5	4.7	3.8	2.2	3.0	2.5
Pelvic & kidney fat-% ⁵	3.43	3.49	3.49	3.94	2.28	1.57	2.35	2.33
Major retail cuts-% ⁶	47.1	48.7	48.7	46.2	51.4	55.8	50.4	53.1
Total freezer meat-% ⁷	67.7	72.6	72.6	71.6	76.3	81.5	81.0	81.3
Bone trim-% ⁸		10.5	10.5	9.5	10.9	11.5	12.0	10.0
Fat trim-% ⁹		16.8	16.8	18.5	12.4	6.8	6.7	8.3
Flavor ¹⁰	8.50	9.60	9.60	9.65	7.43	8.21	7.85	8.70
Juiciness ¹⁰	7.78	9.03	9.03	9.73	7.24	8.36	7.74	8.78
Tenderness ¹⁰	8.56	9.84	9.84	9.23	7.02	7.85	7.57	6.98
Overall acceptability ¹⁰	8.34	9.56	9.56	9.55	7.22	7.88	7.57	7.88
Shear value-lb. ¹¹	5.32	5.36	5.36	5.99	6.93	8.08	7.18	8.01

¹Left side weight after 7-day aging period

²Fat thickness measured at 12th rib

³Higher values = darker color

⁴Higher score, more marbling (3=trace, 4=slight, 5=small)

⁵Expressed as a percent of the side weight

⁶Closely trimmed retail cuts from the round, rib, loin, and chuck expressed as a percent of the side weight

⁷Total yield of freezer meat expressed as a percentage of side weight

⁸Bone removed from side during cutting expressed as a percent of the side weight

⁹Fat removed from side during cutting expressed as a percent of the side weight

¹⁰Higher number = more desirable flavor, juiciness, tenderness, and overall acceptability

¹¹Pounds of force required to shear a 1/2-inch core of broiled longissimus dorsi steak

[(not including ground beef)]

IX. Project summary:

Colorado Agricultural Experiment Station

Cattle Inventory - June 1967				Total
Breed	Hereford		Crossbred	
Line	Inbred	Linecross	Control	SxA
Performance test bulls:				
Summer	10	11		21
Herd bulls (12 mo. or over)	28	1	1	30
Cows (2 yr. or over)	110	140	14	6
Heifers:				
Replacement yearlings	23	14	9	46
Calves (as of June 3)				
Bulls				114
Heifers				102

Cow Production Data - 1966 calf crop				H(SxA)	Total
Number of cows bred to calve:					
As 2-yr. olds	19	31	2		52
At 3 yr. and up	110	130	25	8	273
Number calves born from:					
2-yr. olds - alive	11	24	2		37
- dead	1	1	0		2
3-yr. olds and up - alive	82	107	13	7	209
- dead	1	2	2	0	5
Number of calves weaned	82	123	14	7	226
Percent calf crop - born ^a	73.6	83.2	63.0	87.5	77.8
- weaned ^b	88.2	93.9	93.3	100.0	91.9

Prewaning Performance - 1966 calf crop					Average ^c	
Birth weight -	bulls	76.3	77.9	77.3	80.8	77.4
	- heifers	74.6	76.5	74.0	78.0	75.8
		Overall average 76.5				
Weaning age -	bulls	190.0	194.0	212.0	198.0	192.6
	- heifers	195.0	195.7	210.0	207.0	196.5
		Overall average 194.6				
Weaning weight -	bulls	384.6	438.1	417.5	495.0	415.7
	- heifers	364.7	411.9	388.0	426.6	391.5
		Overall average 404.3				
Adjusted ^d weaning weight -	bulls	438.8	460.3	-	496.0	451.6
	- heifers	434.8	456.3	401.6	438.6	445.7
		Overall average 448.5				
Weaning score:						
Conformation -	bulls	42.8	47.0	-	51.0	45.2
	- heifers	44.5	48.7	51.4	48.0	47.4
		Overall average 46.4				
Average inbreeding -	bulls	0.295	0	0	0	
	- heifers	0.34	0	0	0	

^aNumber born/number cows bred^bNumber weaned/number born alive^cWeighted averages^dAdjusted for age of dam, age of calf, inbreeding of dam, inbreeding of calf, and sex (Harwin Model 3)

Colorado Agricultural Experiment Station

Postweaning Performance - 1966 calf crop				Total or Average
Breed	Hereford	Hereford	H(SxA)	
Line	Inbred	Linecross	Crossbred	
Sex	Bull	Bull	Bull	
Method of feeding	Individual	Individual	Individual	
Number on test	26	44	2	72
Average age on test	260.4	257.0	256.0	258.2
Initial weight	475.4	493.5	553.0	488.6
Days on test	140	140	140	140
Average daily gain	2.59	2.80	3.01	2.73
Feed efficiency:				
TDN/100 lb. gain	7.22	7.08	6.99	7.13
Final weight	834.7	891.2	975.0	873.1
Final score:				
Conformation	4.28	4.69	5.18	4.56
Average inbreeding	0.333			
Controls were on Coors test				

COLORADO STATE UNIVERSITY

- I. Station: Colorado Agricultural Experiment Station
- II. Project title: The heritability of various components of serum lipids and their relationship to the composition and distribution of fat in beef cattle (Project 28)

III. Personnel:

Experiment Station:

D. A. Cramer, Project Leader, J. S. Brinks and B. E. Thrall

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

IV. Nature and extent of work done this year:

Blood serum and 12th rib cuts have been obtained from 482 beef cattle representing nine western stations over a two year period. Determinations of fatty acid composition of the tissue lipids are almost complete. All of the tissues have been extracted for lipid analysis. The completed results of the fatty acid analyses will be reported next year.

In addition to the fatty acid composition of the tissue lipids, the major lipid classes (phospholipids, free fatty acids, triglycerides, and cholesterol esters) of the intramuscular, inner subcutaneous, outer subcutaneous, and blood serum lipids from the 1965 Miles City samples (35 animals) have been separated by TLC and the fatty acid composition of each class determined by GLC.

The results of this analysis are listed in table 1. The means in table 1 are averages of all 35 animals. Standard deviations have been omitted from the table because of space limitations. The coefficients of variation indicate that the data are quite variable. The four fatty acids (palmitic, stearic, oleic, and linoleic acids) that comprise 80 to 90 percent of the total fatty acids have a coefficient of variation range of 20 to 130 percent in blood serum, 10 to 140 percent in intramuscular fat, and 10 to 130 percent in subcutaneous fat. The ranges are misleading, however, because on the average the coefficient of variation for blood serum lipids is 42.5 percent, for intramuscular fats the average is 38.5 percent, and for subcutaneous fat it is 25.5 percent. These differences are probably a reflection of the stability of the lipids in the different tissues. Serum lipids are in a very dynamic state and turn over quite fast. Intramuscular fats, also, probably turn over fairly fast, and subcutaneous lipids are relatively stable.

An analysis of variance has been run to determine sire differences in the composition of the various lipid classes (tables 4 and 5).

Table 1. Average Fatty Acid Composition of Various Tissue Lipid Classes from 1965 Beef Cattle
from United States Range Livestock Experiment Station, Miles City, Montana

Fatty acid percentage composition listed by carbon chain length and degree of unsaturation																			
Tissue and lipid class	Iodine number	10	11	12	13	14	14:1	15	15:1	16	16:1	17	17:1	18	18:1	18:2	20		
Blood serum lipids																			
Phospholipids	56.5	0.1	0.1	0.1	0.0	0.1	2.6	0.1	0.2	23.7	3.5	0.8	0.2	27.9	27.2	12.8	0.4		
Free fatty acids	47.6	0.1	0.1	0.1	0.0	0.1	3.5	0.2	0.2	27.4	4.6	0.6	0.2	23.2	32.7	5.1	0.3		
Triglycerides	60.2	0.4	0.6	0.1	0.1	0.2	4.5	0.4	0.3	25.9	4.9	0.5	0.4	18.6	30.5	12.2	0.7		
Cholesterol esters	71.9	1.4	2.8	0.6	0.2	1.6	3.1	0.3	0.3	22.3	3.7	0.3	0.3	15.1	23.8	22.0	1.1		
Intramuscular lipids																			
Phospholipids	68.7	0.1	0.1	0.1	0.0	0.0	2.5	0.3	0.3	21.2	5.2	1.0	1.4	16.9	32.5	15.3	1.3		
Free fatty acids	54.2	0.0	0.0	0.2	0.0	0.0	2.6	0.4	0.4	25.7	5.9	1.6	1.2	19.6	34.2	6.9	1.0		
Triglycerides	51.2	0.0	0.0	0.2	0.0	0.0	2.9	0.7	0.4	26.4	4.9	1.6	1.0	18.9	37.6	4.0	0.9		
Cholesterol esters	45.5	2.1	0.5	3.6	0.0	1.4	5.7	0.5	0.3	25.6	5.5	0.4	0.4	16.5	30.1	4.7	0.5		
Outer Subcutaneous fats																			
Total lipids	55.9	0.1	0.0	0.1	0.0	0.0	3.4	1.3	0.6	25.1	6.5	1.8	1.3	14.4	41.1	3.5	0.6		
Triglycerides	54.6	0.0	0.0	0.1	0.0	0.0	3.2	1.2	0.6	25.6	6.2	1.9	1.1	15.3	40.9	3.1	0.4		
Inner subcutaneous fats																			
Total lipids	52.1	0.0	0.0	0.0	0.0	0.0	3.4	1.2	0.6	25.5	5.6	1.7	0.9	18.0	39.3	3.0	0.4		
Triglycerides	51.0	0.1	0.0	0.1	0.0	0.0	3.3	1.2	0.7	25.1	5.5	2.1	1.3	18.4	38.1	3.1	0.5		

V. Summary of progress and conclusions to date:

In looking at the data on an individual animal basis it was noted that the composition of subcutaneous fats was quite similar, not only among animals but also among stations; whereas the fatty acid composition of intramuscular and serum lipids are widely variable among animals, stations, and lipid classes. It appears that subcutaneous fats, being primarily a storage tissue, are relatively independent of genetic control and environmental influence. Intramuscular and serum lipids may respond more to selection and environmental treatment. However, the high coefficients of variation obtained with the 1965 Miles City samples indicate that precise control over the environment and sampling techniques is necessary in a selection program.

In addition to the expected large differences in the fatty composition of the various lipid classes in table 1, the differences between the inner and outer layers of subcutaneous fat are of interest. A difference of almost four units in iodine numbers is quite large and is accounted for almost entirely by the three 18-carbon acids. This brings up the question as to why the two layers, which presumably have the same function, are so different chemically. Also, which layer is laid down first and which one is mobilized more readily? The answers to these questions may have a bearing on the production of beef with less outside waste fat.

VI. Application of findings:

The cooperative study with W-1 is a preliminary investigation to establish a base analysis on the composition of serum and adipose lipids in beef cattle and to observe possible sire differences. Therefore, the major application of the findings will be to direct further research on genetic and environmental variation in lipid composition and fat distribution in beef cattle.

VII. Work planned for the future:

The determination of various lipid classes and fatty acid composition of each class of serum, intramuscular, and subcutaneous fats from large numbers of beef cattle is very time consuming. As the cooperative project terminates June 30, 1968, samples will not be collected from cooperating stations this year. Instead, the remainder of the budget will be used to complete the analyses on the samples obtained in 1965 and 1966. Hopefully, the analyses will be finished this coming year and a final report will be submitted at the technical committee meeting in 1968.

VIII. Publications:

None

Table 2. Percent Intramuscular Dry Matter and Fat
Station Means - 1966

Station	Number samples		% D.M.	% Fat on D.M. basis
Oregon	25	$\bar{x}$	22.32	7.63
		s^2	1.18	4.97
		s	1.08	2.22
Havre	42	$\bar{x}$	24.82	15.99
		s^2	2.84	9.72
		s	1.68	3.12
New Mexico	29	$\bar{x}$	22.81	8.72
		s^2	0.57	5.61
		s	1.68	3.12
Washington	8	$\bar{x}$	23.73	18.12
		s^2	2.73	26.83
		s	1.65	5.17
Hawaii	12	$\bar{x}$	29.19	19.78
		s^2	2.19	31.14
		s	1.48	5.58
Miles City	29	$\bar{x}$	25.15	7.45
		s^2	1.06	3.06
		s	1.02	1.75

$\bar{x}$ = station mean

s^2 = variance

s = standard deviation

Table 3. Subcutaneous Fatty Acid Composition
Station Means, Variance and Standard Deviation - 1965

Station	Number samples	Fatty acid percentage composition listed by carbon chain length and degree of unsaturation											Iodine number
		14	14:1	16	16:1	17	iso-18	18	18:1	18:2	20		
Total fatty acids													
Miles City													
Inner	35	$\bar{x}$	3.40	1.20	25.50	5.60	1.70	0.90	18.00	39.30	3.00	0.40	52.1
		s^2	0.33	0.08	6.63	1.20	0.18	0.12	14.09	14.84	1.07	0.31	
		s	0.57	0.28	2.58	1.10	0.43	0.34	3.75	3.85	1.04	0.56	
Outer	35	$\bar{x}$	3.40	1.30	25.10	6.50	1.80	1.30	14.40	41.10	3.50	0.60	55.9
		s^2	0.26	0.10	4.96	1.00	0.14	0.17	9.06	6.91	2.82	0.54	
		s	0.51	0.31	2.23	1.00	0.38	0.41	3.10	2.63	1.68	0.74	
Montana	7	$\bar{x}$	4.10	2.10	26.90	7.60	1.40	1.60	9.40	41.20	2.50	1.40	
		s^2	0.36	0.38	4.11	1.19	0.12	0.12	3.68	4.36	0.26	0.12	
		s	0.60	0.62	2.02	1.09	0.34	0.34	1.91	2.09	0.51	0.34	
New Mexico	29	$\bar{x}$	5.10	2.20	30.70	6.60	1.00	0.80	11.50	38.00	2.30	0.70	
		s^2	0.47	0.18	2.71	0.90	0.06	0.08	2.14	3.33	0.40	0.10	
		s	0.68	0.42	1.65	0.95	0.24	0.28	1.46	1.82	0.63	0.31	
Washington	11	$\bar{x}$	3.70	1.80	27.80	6.80	1.30	1.20	13.90	38.70	2.40	1.10	
		s^2	0.36	0.03	7.03	0.75	0.05	0.29	2.98	4.87	0.63	0.33	
		s	0.60	0.17	2.64	0.87	0.22	0.54	1.72	2.20	0.79	0.57	
Havre	28	$\bar{x}$	3.90	1.70	27.30	6.60	1.20	1.00	11.90	43.20	1.90	0.50	
		s^2	0.38	0.08	3.10	0.69	0.08	0.11	3.10	7.96	0.35	0.13	
		s	0.62	0.28	1.75	0.83	0.28	0.33	1.75	2.82	0.59	0.36	

(Continued)

(Continued)

Table 3. Subcutaneous Fatty Acid Composition
Station Means, Variance and Standard Deviation - 1965
(Continued)

Station	Number samples	Fatty acid percentage composition listed by carbon chain length and degree of unsaturation										Iodine number	
		14	14:1	15	16:1	17	iso-18	18	18:1	18:2	20		
Triglycerides													
Miles City													
Inner	35	3.30	1.20	25.10	5.50	2.10	1.30	18.40	38.10	3.10	0.50	51.0	
	s ²	0.32	0.12	4.35	0.80	0.56	0.57	7.63	14.51	1.81	0.45		
	s	0.57	0.35	2.09	0.90	0.75	0.78	2.76	3.81	1.34	0.67		
Outer	35	3.20	1.20	25.60	6.20	1.90	1.10	15.30	40.90	3.10	0.40	54.6	
	s ²	0.34	0.14	8.18	1.78	0.48	0.24	8.94	9.33	1.71	0.34		
	s	0.58	0.42	2.86	1.33	0.69	0.49	2.99	3.05	1.31	0.61		
Montana	7	4.00	1.90	28.40	7.20	1.20	1.30	9.80	42.10	1.90	0.80		
	s ²	0.33	0.35	1.62	1.13	0.03	0.07	3.71	2.60	0.52	0.18		
	s	0.57	0.50	1.27	1.06	0.28	0.26	1.92	1.61	0.72	0.42		
New Mexico	29	5.10	2.10	30.60	6.50	1.10	0.90	11.80	37.80	2.40	0.60		
	s ²	0.35	0.14	1.91	0.79	0.06	0.07	2.26	3.65	0.49	0.14		
	s	0.59	0.37	1.38	0.89	0.24	0.26	1.50	1.91	0.70	0.37		
Washington	11	3.80	1.80	27.40	6.70	1.30	1.20	14.00	38.80	2.50	1.20		
	s ²	0.41	0.04	4.60	0.68	0.09	0.16	3.08	9.68	0.54	0.22		
	s	0.64	0.20	2.14	0.82	0.30	0.40	1.75	3.10	0.73	0.46		
Havre	28	3.80	1.60	27.20	6.40	1.20	1.10	12.40	43.10	1.90	0.40		
	s ²	0.32	0.06	2.61	0.60	0.05	0.07	2.83	6.47	0.35	0.06		
	s	0.56	0.24	1.61	0.78	0.22	0.26	1.67	2.53	0.59	0.24		

Table 4. Significance of Differences Between Lines in Fatty Acid Composition
of Lipid Fractions from 1965 Miles City Cattle

Lipid fraction	10	11	12	13	iso-			14	14	14:1	15	iso-			16	16:1	17	18	18:1	18:2	20	Iodine number
Blood serum																						
Total lipids								**	**	**	**				*		**					
Phospholipids																		**			**	
Free fatty acids																						
Triglycerides								**							*	*	*			**	**	
Cholesterol esters	**	**		*				*	**	**					**	*		*	*	*	*	**
Intramuscular fat																						
Total lipids															*				*			
Phospholipids																						
Free fatty acids	*		*																*			
Triglycerides																						
Cholesterol esters																					*	
Outer subcutaneous fat																						
Total lipids															**					**		
Triglycerides								**		*											**	
Inner subcutaneous fat																						
Total lipids								**										*				*
Triglycerides							**	**													*	

Table 5. Significance of Differences Between Sires Within Lines in Fatty Acid Composition
of Lipid Fractions from 1965 Miles City Cattle

Lipid fraction	Line	10	11	12	13	iso-			14	14:1	15	iso-		16	16:1	17	18	18:1	18:2	Iodine 20 number
Blood serum																				
Total lipids																				
	1													*	*			**	*	**
	2																			
	3							*												
Phospholipids																				
	1																			
	2													**	**		*	**	*	**
	3													*	*	**	**	**	*	**
Free fatty acids																				
	1																			
	2														**		*		*	
	3																			
Triglycerides																				
	1		*				**							**			*	**	**	**
	2																			
	3																			
Cholesterol esters																				
	1																*			
	2												**							
	3			*					*										*	*

(Continued)

Table 5. Significance of Differences Between Sires Within Lines in Fatty Acid Composition
of Lipid Fractions from 1935 Miles City Cattle

(Continued)																
Lipid fraction	Line	10	11	12	13	iso-			iso-			iso-			Iodine	
						14	14	14	14:1	15	16	16:1	17	18	18:1	20 number
Intramuscular fat																
Total lipids	1				*											
	2													*		
	3										*					*
Phospholipids	1			*												
	2															
	3															
Free fatty acids	1				*											
	2											*				
	3	*		**			*									
Triglycerides	1															
	2	*	**													
	3							**	*							*
Cholesterol esters	1											*				
	2				*											
	3															

(Continued)

UNIVERSITY OF HAWAII

- I. Station: Hawaii Agricultural Experiment Station
- II. Project title: 1. The estimation of genetic and phenotypic parameters in populations of beef cattle in Hawaii and their use in selection programs. 2. A study of heterosis from crosses among breeds of beef cattle.
- III. Personnel:
- Experiment Station:
Estel Cobb, Project Leader, Oliver Wayman, Isaac I. Iwanaga, Kiyoichi Morita, Diedrich Reimer, and Richard Indrieri
- Hawaii Ranch Company
Tom Liggett and Carl Bredhoff
- Kahua Ranch Company, Ltd.
H. M. Richards, Jr.
- U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
Bradford W. Knapp, Acting Investigations Leader
- IV. and V. Nature and extent of work done this year and summary of progress:

The collections of data on the Hawaiian Ranch Company herd were obtained as scheduled.

The testing of inbred lines in connection with the Arizona station was continued during the year. Four lines were used again at Hawaiian Ranch Company. One hundred twenty cows were bred under this phase of the project (30 per line). The following number of calves were born per line in 1966:

	Male	Female
MSC Clay's Supreme 33	10	8
L4 Mischief 100	3	7
KCE 311	10	8
Royal 0006	4	3

Semen from six of the lines was used again this year at Kahua Ranch Company to breed 180 cows (about 30 per line). Fifty-eight calves were born as a result of last year's matings. The results of the weaning for the 1965 breeding are shown in table 1.

The data for the first five years on progeny testing under two feeding regimes were summarized during the year and are being used for a Master of Science thesis to be completed this summer. The data were

Table 1. Results of Weaning for 1965 Breeding

Sire	Male			Female		
	Number calves	Average	Confor-	Number calves	Average	Confor-
		daily gain B-W	mation score		daily gain B-W	mation score
KC E 311	3	1.36	11+	9	1.19	11
Reno E 307	3	1.48	11	10	1.31	11+
L4 100	8	1.55	12-	10	1.42	12-
Gillette Arden 71	3	1.50	12-	3	1.33	11+
Royal 0006	4	1.47	10+	7	1.23	11+
Clay's Supreme 33	5	1.45	11+	2	1.28	11-

first analyzed for each year separately. The only significant sire by treatment interactions found were for average daily gain in 1959 and rib-eye area in 1963. In general, the mean squares for sire by treatment interaction were small and nonsignificant. The pooled analysis is not complete.

A study was made of the relationships among the fatty acid content of intramuscular beef fat and animal performance, carcass scores, and meat quality. The highest correlations were found between the fatty acid content of the intramuscular fat and flavor and tenderness. The longissimus dorsi content of oleic acid (C18.1) was significantly correlated with flavor score (0.502). The stearic acid (C18) content was negatively correlated with flavor score (-.349). High correlations were found between tenderness and the content of C14, C16, and C18.1. The multiple correlation between the content of C14, C18, and C18.1 and flavor score was 0.52. The multiple correlation between C14, C16, and C18.1 and tenderness was 0.50.

Breeding groups were made up according to the schedule of rotating cows annually among the Hereford, Charolais, and Angus sire groups. Birth weights only are available to date on the 1967 calf crop. Average birth weights for all calves were slightly higher in 1967 compared to a year ago, and crossbred calves again outweighed the straightbreds at birth. Death loss at calving was reduced to six calves this year. All calves lost were crossbreds, with an equal number sired by individual Charolais and Hereford bulls. Four of the six calves lost came from first-calf Angus heifers.

Weaning weights and grades were obtained on the 1966 calf crop. Crossbred calves were considerably heavier at weaning. The overall advantage in favor of the crossbreds was 19 pounds. Charolais-sired calves averaged 25 pounds heavier at weaning than the straightbreds. All calves had satisfactory growth rate during the first 100 days post-weaning, but then showed a definite decline during the next 50-day period. Conformation score at weaning did not show a great deal of variation.

Yearling weights and conformation scores favored the crossbred calves. Eighteen steer calves averaging about 600 pounds, and representing all breeding groups, were sent to the Waialeale Research Farm on

Oahu for feedlot studies and carcass information at slaughter weights of 1000 pounds.

Additions to the breeding herd this year include two Hereford bulls and one Angus bull, all obtained from Hawaii breeders.

VI. Application of findings:

Preliminary results indicate that crossbred calves are heavier at birth and at weaning than straightbred calves. Birth weight and size of calf at birth appear to be important factors contributing to calving difficulties and death losses at birth, particularly where the dams concerned are first-calf heifers.

VII. Work planned for the future:

The crossbreeding project will continue as shown in the project outline. The testing of the inbred lines from the Arizona project will be continued at both Hawaiian Ranch Company and Kahua Ranch Company. The analysis of data will be continued.

VIII. Publications and manuscripts:

Reimer, Diedrich. 1966. Hybrid cattle vs. straight cattle. Mealani Beef Cattle Field Day. August 27. Mimeog. Rpt.

Cobb, Estel. 1966. Progeny testing under two different feeding regimes. Mealani Beef Cattle Field Day. August 27. Mimeog. Rpt.

Cobb, Estel and R. W. Stanley. 1967. Relationships among fatty acid content of intramuscular beef fat and animal performance, carcass scores, and meat quality. Manuscript prepared.

IX. Project summary:

Hawaii Agricultural Experiment Station

Cattle Inventory - June 1967

Breed	Hereford
Line	Hawaiian Ranch Co.
Grade	Grade
Bulls (12 mo. or over)	110
Cows (2 yr. or over)	350
Heifers (yearlings)	150
Calves - Bulls	180
- Heifers	156

Cow Production Data - 1966 calf crop

Number cows bred to calve:	
At 3 yr. and up	416
Number calves born from:	
3-yr.-olds and up - Alive	337
- Dead	22
Number calves weaned	322
Percent calf crop ^a - Born	81.0
- Weaned	77.0

^aBased on number of cows exposed to the bull and number born alive

Preweaning Performance - 1966 calf crop

Weaning age - Bulls	208
- Heifers	208
Weaning weight - Bulls	413
- Heifers	385
Adjusted weaning weight ^b - Bulls	466
- Heifers	434
Weaning score:	
Conformation ^c - Bulls	11.1
- Heifers	11.1

$$^b \text{ Adjusted 240-day weight} = \left(\frac{\text{weaning weight} - 70}{\text{age in days}} \times 240 \right) + 70$$

^cBased on feeder grades where 17, 16, 15 = Prime; 14, 13, 12 = Choice; 11, 10, 9 = Good, etc.

Hawaii Agricultural Experiment Station

Crossbreeding Work

Cattle Inventory - June 1967

Breed	Hereford	Angus	Charolais	Crossbred	Total
Bulls (12 mo. or over):					
Purebred	2	2	2	0	6
Grade	1	1	0	4	6
Cows (2 yr. or over):					
Grade	56	58	0	0	114
Heifers (yearlings)	5	4	0	26	35
Steers (yearlings)	8	7	0	20	35
Calves - Bulls	10	4	0	26	40
- Heifers	8	9	0	34	51

Cow Production Data - 1966 calf crop

Breeding group	HxH	AxA	HxA	AxH	CxH	CxA	Total
Number cows bred to calve:							
At 3 yr. and up	19	15	10	20	19	8	91
Number calves born - Alive							
	16	11	9	18	15	4	73
- Dead	2	0	0	0	3	2	7
Number calves weaned							
	13	11	9	18	15	4	70
Percent calf crop ^a :							
Born	84.2	73.3	90.0	90.0	79.0	50.0	80.2
Weaned	68.4	73.3	90.0	90.0	79.0	50.0	76.9

^aBased on number cows exposed and number calves born alive

Preweaning Performance - 1966 calf crop

Breeding group	HxH	AxA	HxA	AxH	CxH	CxA
Birth weights - Bulls						
	77	63	71	75	82	83
- Heifers	70	66	69	76	77	68
Weaning age - Bulls						
	203	217	194	219	205	200
- Heifers	201	220	196	217	216	206
Weaning weight - Bulls						
	375	351	376	390	398	407
- Heifers	323	344	343	392	358	394
Adjusted weaning weight ^b - Bulls						
	428	380	453	421	451	472
- Heifers	368	370	408	376	388	450
Conformation score ^c :						
Bulls	11.2	11.0	11.0	11.5	11.0	10.5
Heifers	11.4	10.8	11.0	10.7	11.2	11.5

^bAdjusted 240-day weight = weaning weight + ADG (240-weaning age)

^cBased on feeder grades where 17-15 = Prime; 14-12 = Choice; 11-9 = Good, etc.

Hawaii Agricultural Experiment Station

Cow Production Data - 1967 calf crop

Breeding group	HxH	AxA	HxA	AxH	CxH	CxA	Total
Number cows bred to calve:							
At 3 yr. and up	20	14	17	19	19	17	106
Number calves born - Alive	18	13	12	18	17	13	91
- Dead	0	0	3	0	2	1	6
Percent calf crop ^a - Born	90.0	92.8	70.6	94.7	89.5	76.5	85.8

a Based on number of cows exposed and number of calves born alive

Preweaning Performance - 1967 calf crop

Breeding group	HxH	AxA	HxA	AxH	CxH	CxA	Total
Birth weights - Bull	79	72	75	78	91	92	81
- Heifer	72	64	69	69	80	73	71

UNIVERSITY OF IDAHO

- I. Station: Idaho Agricultural Experiment Station
- II. Project title: The improvement of economically important traits in beef cattle with special emphasis on fertility and carcass quality
- III. Personnel:
 - Experiment Station:
 - R. E. Christian, Project Leader, T. D. Bell, M. L. Hemstrom, L. E. Orme, C. W. Hodgson, and S. E. Slyter
 - U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
 - Bradford W. Knapp, Acting Investigations Leader
- IV. and V. Nature and extent of work done this year and summary of progress and conclusions to date:

The data from the three-year study of the progeny of the eight Hereford bulls used on four farms (two bulls per farm) were analyzed to determine the relative importance of sire differences, farm differences, and year differences on production traits and carcass traits. Sire differences were found for only one initial subjective body score (body depth). However, sire differences were found for subjective scores at the time of slaughter for body depth, length of rump, thickness of round, width of loin, width of body, scale and substance, overall grade, and average score. There were no significant sire differences found for any carcass trait studied. Significant differences due to years and to farms were apparent for all initial subjective scores and for most final subjective scores. None of the initial subjective scores were correlated significantly with average daily gain in the feedlot. Also, the correlations between initial subjective scores and carcass traits were generally too low to be of much predictive value.

The first progeny from six bulls (two Herefords, two Angus, and two Shorthorns) leased to one cooperator are now in the feedlot and will be slaughtered later this year.

Most studies on fertility in beef cattle have failed to show that fertility is highly heritable. One of the major difficulties is that fertility has been assumed to be binomially distributed. Preliminary studies indicate that fertility actually approximates the geometric distribution: The waiting time to the first success, or the probability that the first success occurs at the $k + 1$ 'st trial, equals pq^k . This distribution has a mean of $1/p$ and a variance of q/p^2 . Several approaches have been used to determine how well actual data on fertility fit the geometric distribution (table 1). Table 2 shows the

expected percentage calf crop for various levels of fertility (p). These calculated percentages appear to approximate quite closely the data reported by various authors.

Table 1. Percentage of Cows Pregnant after 1st, 2nd, 3rd, and 4th Service Using Various Methods of Calculation

Ser- vice No.	Adapted from Barrett et al. 1948 ^a		Geometric distribution ^b		Four percent permanently sterile Probability of conception = 0.567 ^c	
	% pregnant		% pregnant		% pregnant	
	Percentage pregnancy	from this service	Percentage pregnancy	from this service	Percentage pregnancy	from this service
1	54.4	54.4	54.4	54.4	54.4	54.4
2	50.7	23.1	54.4	24.8	51.7	23.6
3	46.5	10.4	54.4	11.3	45.4	10.2
4	38.2	4.6	54.4	5.2	37.5	4.4
Total percent pregnant after four services		92.5			95.7	92.6

^aThese figures were calculated from the data presented by Barrett et al. (J. Dairy Sci. 31:683). They give the percentage pregnancy in their paper, and the actual percentage of cows that are pregnant from each succeeding service was calculated.

^bThe approximation to the geometric distribution ($P(X=k+1)=pq^k$), using a constant probability of pregnancy ($p=.544$).

^cAssuming that 4 percent of the first-service cows are permanently sterile (not much different from some reports) and using a constant probability of conception ($p=.567$) for the remainder of the cows, the observed percentages of pregnancy were obtained. From this the percentage that actually are pregnant from each service was calculated.

Table 2. Percentage of Females That Will Conceive at Service Number n and Expected Total Calf Crop if a Maximum of Four Services Are Allowed, for Various Values of p

P =	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
N = 1	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
2	9.00	16.00	21.00	24.00	25.00	24.00	21.00	16.00	9.00
3	8.10	12.80	14.70	14.40	12.50	9.60	6.30	3.20	0.90
4	7.29	10.24	9.48	8.64	6.25	3.84	1.89	0.64	0.09
Total per- cent calf crop	34.39	59.04	75.18	87.04	93.75	96.44	99.19	99.84	99.99

The other major problem really is not concerned directly with fertility but greatly affects the estimates of heritability obtained.

What is the effect on the progeny test if the number of observations is determined by the level of phenotypic expression of the trait?

This is precisely what occurs with any study of fertility. Every time an attempt is made to measure fertility of the individual cow, we are actually conducting a progeny test of that individual; we cannot obtain the phenotype of the individual itself.

Each gamete produced contains a sample half of the genes which the individual possesses. If that gamete is fertilized and results in a live calf, we obtain only a single observation of that individual. If the first service is infertile and the second service fertile, we have two observations, etc. Thus, we obtain fewer observations on the more fertile animals.

VI. Application of findings:

Because of the large farm differences and year differences, beef cattle breeders should be hesitant to compare groups of offspring of bulls from different farms or attempt to compare offspring of bulls from the same farm raised in different years. From the results of this study on progeny testing beef bulls, breeders should not expect to find significant differences between pairs of bulls used in their own herds.

VII. Work planned for the future:

The crossbreeding study using Hereford, Angus, and Shorthorn bulls in a commercial herd will be continued. Six Hereford bulls have been leased to one cooperator to determine if sire differences are apparent when larger groups of bulls are compared in one herd.

The study of the effects on the progeny test of varying the number of observations depending upon phenotype will be continued. Also, it is planned to determine the effect on the estimate of heritability of a quantitative trait (weaning weight) if the trait is recorded as a qualitative trait.

VIII. Publications and manuscripts:

Bettesworth, J. M. 1967. Sire effects on production and performance traits in Hereford cattle. M. S. Thesis. University of Idaho. Moscow.

IX. Project summary:

Idaho Agricultural Experiment Station

Cattle Inventory - June 1967

Breed	Hereford	Angus	Shorthorn	Total
Purebred or grade		Purebred		
Bulls (12 mo. or over)	14	5	5	24
Cows (2 yr. or over)	52	31	25	108
Heifers (yearlings)	25	11	10	46
Calves - Bulls	24	10	9	43
- Heifers	17	14	7	38

Cow Production Data - 1966 Calf Crop

Number cows bred to calve:				
As 2-yr.-olds	5	4	0	9
At 3 yr. and up	44	24	27	95
Number calves born from:				
2-yr.-olds - Alive	3	2	0	5
- Dead	1	1	0	2
3-yr.-olds and up - Alive	41	23	21	85
- Dead	3	1	5	9
Number calves weaned	43	25	20	88
Percent calf crop ^a - Born	89.8	89.3	77.8	86.5
- Weaned	87.8	89.3	74.1	84.6

^aCalves born alive and calves weaned to cows exposed.

Prewaning Performance - 1966 calf crop

				Average
Birth weight - Bulls	68.7	62.2	67.0	66.5
- Heifers	65.6	58.1	62.8	62.6
Weaning age - Bulls	181.5	198.8	184.2	187.2
- Heifers	189.7	196.3	184.4	190.5
Weaning weight - Bulls	412.8	429.1	404.5	415.4
- Heifers	383.3	376.9	358.8	375.4
Adjusted weaning - Bulls	458.9	452.9	452.0	455.4
weight-205 days - Heifers	424.8	444.9	443.0	435.6
Weaning score:				
Conformation - Bulls	10.7	11.3	11.0	11.0
- Heifers	10.0	11.2	10.9	10.6

Postweaning Performance - 1966 calf crop

Sex	Bull	Bull	Bull	
Method of feeding		Individual		
Number on test	9	4	5	18
Average age on test	259.1	263.5	254.8	259.5
Initial weight	485.0	480.5	434.0	469.8
Initial Score: Conformation	11.0	12.5	11.6	11.5
Days on test	112	112	112	112
Average daily gain	2.31	2.48	2.24	2.33
Feed efficiency:				
TDN/100 lb. gain	423.0	403.4	411.6	415.5
Final weight	743.8	758.2	685.0	730.7
Final score: Conformation	11.3	12.2	12.2	11.8
Average inbreeding	0	0	0	0

MONTANA STATE UNIVERSITY

- I. Station: Montana Agricultural Experiment Station
- II. Project title: Recurrent selection and record of performance selection in open and closed beef cattle herds
- III. Personnel:

Experiment Station:

R. L. Blackwell, Project Leader, F. S. Willson, A. E. Flower, Claude Windecker, J. R. Dynes, and R. W. Miller

U. S. Department of Agriculture, Agricultural Research Service
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

- IV. and V. Nature and extent of work done this year and summary

The routine procedures for obtaining performance records on the various lines of cattle were followed at Havre and Bozeman. Yearling bulls were selected for replacements according to past procedures. The Angus bulls now in use have all been selected from within the herd. Forty yearling crossline heifers from the Havre station were brought to the Red Bluff Research Ranch in the fall of 1966 to obtain calf production data and to be used in range nutrition studies.

Comparisons between crossline steers produced at the Havre station, rancher cooperator steers sired by Havre Line I bulls, and choice feeder grade steers purchased on the open market were made. This phase of the program will be terminated with past feeding season. One more group of Angus calves from cooperators will be fed, thus terminating that phase of work.

A plan for evaluating the five inbred lines of Herefords was developed and initiated at Havre with the 1967 breeding season. This involved all possible linecrosses among the four lines at Havre plus the ROP line developed at Bozeman. This latter line consisting of 50 cows and yearling heifers and two bulls were moved to the Havre station this spring. Two bulls per line will be mated to cows from each of the five lines. In addition, the purebred Havre Line 4 cows (from Miles City Line 1) were straight bred due to a need for increasing numbers in this group. The recurrent selection aspect of the Havre program has been temporarily discontinued.

Thirty-seven crossline yearling heifers from Havre were moved to Bozeman for breeding and to obtain calf production data. We plan to maintain these until three calf crops have been produced.

- VI. Application of findings:

No new findings in the past year.

VII. Work planned for the future:

The lines of Hereford cattle (five) developed at Havre and Bozeman will be evaluated by line crossing in terms of carcass merit and other production factors of steers produced from these matings and calf production of the females. This will provide additional information on general and specific line effects. Linecrosses will be made for at least two consecutive years (1967 and 1968) and possibly for a third if numbers of females in the lines can be maintained satisfactorily. Line numbers currently are from 40 to 50 females, with the 1967 calf crop available for replacements.

Plans for the Angus herd at Bozeman are not firm at this time. However, it is to be closed temporarily, at least, and a somewhat different selection program initiated. Carcass merit will probably be the major concern in the selection program.

VIII. Publications and manuscripts:

None

IX. Project summary:

Montana Agricultural Experiment Station

Bozeman

Cattle Inventory - June 1967				Total
Breed Line	Hereford ROP	Hereford	Angus ROP	
Purebred or grade	Purebred	Purebred	Purebred	
Bulls (12 mo. or over)	14	4	18	36
Cows (2 yr. or over)	42	23	52	117
Heifers (yearlings)	12	6	14	32
Calves - Bulls	24	5	29	58
- Heifers	18	10	13	41

Cow Production Data - 1966 calf crop				
Number cows bred to calve:				
As 2-yr.-olds	8	3	14	25
At 3 yr. and up	30	13	35	78
Number calves born from:				
2-yr.olds - Alive	7	3	10	20
- Dead	0	0	3	3
3-yr.-olds and up - Alive	27	12	35	74
- Dead	2	0	0	2
Number of calves weaned	33	14	45	92
Percent calf crop ^a - Born	94.74	93.75	98.0	
- Weaned	86.8	87.5	91.8	

^aCalves born and calves weaned/cows exposed = % calf crop

Prewaning Performance - 1966 calf crop			
Birth weight - Bulls	74.6	72.0	66.8
- Heifers	70.3	67.8	61.7
Weaning age - Bulls	186	188	186.8
- Heifers	186	188.6	188.6
Weaning weight - Bulls	406.5	437.0	472.8
- Heifers	382.8	361.0	413.5
Adjusted weaning weight ^b - Bulls	457.4	473.8	527.5
- Heifers	432.5	405.0	462.8
Weaning score:			
Conformation - Bulls	80	81	82
- Heifers	77	79	82

^bAdjusted to 205 days and age of dam

Montana Agricultural Experiment Station

Bozeman

Postweaning Performance - 1966 calf crop

Breed	Hereford	Hereford	Angus	Hereford	Hereford	Angus
Line	ROP	Visual	ROP	ROP	Visual	ROP
Sex	Bulls	Bulls	Bulls	Heifers	Heifers	Heifers
Method of feeding	Group	Group	Group	Group	Group	Group
Number on test	13	5	16	12	6	14
Average age on test	211	220	215	214	215	216.6
Initial weight	465	470	525	446	432	474
Initial score:						
Conformation	82	83	83	80	81	83
Days on test	140	140	140	140	140	140
Average daily gain	2.72	2.42	2.80	1.38	0.88	1.44
Feed efficiency:						
Feed/100 lb.-Grain	518	518	581			
gain -Hay	102	102	268			
-Total	620	620	849			
Final weight	846	817	924	642	573	676
Final score:						
Conformation	81	80	81	81	81	82

Montana Agricultural Experiment Station

Havre

Cattle Inventory - June 1967						Total
Breed	Hereford					
Line	HL 1	HL 2	HL 3	MC Controls		
	Purebred			Purebred	Grade	
Purebred or grade						
Bulls (12 mo. or over)	14	14	14	5		47
Cows (2 yr. or over)	32	31	33	33	109	238
Heifers (yearlings)	13	14	9	8	1	45
Calves - Bulls	8	9	10	16		43
- Steers	2	2			30	34
- Heifers	14	11	15	9	44	93

Cow Production Data - 1966 calf crop

Number cows bred to calve:					
As 2-yr-olds	4	9	6	10	29
At 3 yr. and up	31	27	27	22	107
Number calves born from:					
2-yr.-olds - Alive	3	6	2	4	15
- Dead	0	2	2	0	4
3-yr.-olds and up - Alive	26	24	21	7	78
- Dead	0	1	1		2
Number calves weaned	27	30	22	11	90
Percent calf crop ^a - Born	82.8	91.7	78.7	34.3	69.1
- Weaned	77.0	83.3	66.6	34.3	47.9

^aCalves born or weaned/number cows exposed

Preweaning Performance - 1966 calf crop

					Average
Birth weight - Bulls	75	80	81	73	77
- Heifers	71	76	77	73	74
Weaning age - Bulls	181	166	174	166	172
- Heifers	183	161	173	158	169
Weaning weight - Bulls	394	388	384	381	387
- Heifers	356	375	379	362	371
Adjusted weaning weight ^b - Bulls	394	414	395	407	403
- Heifers	353	409	390	404	389
Weaning score:					
Conformation - Bulls	3+	2	2-	2+	
- Heifers	3+	2	2	2	
Condition - Bulls	3-	2	2-	2+	
- Heifers	3-	2	2	2	

^b180-day weight

Montana Agricultural Experiment Station

Havre

Postweaning Performance - 1966 calf crop					Total
Breed	Hereford				
Line	HL 1	HL 2	HL 3	HL 4	
Sire	942	730	39	1124	
Sex	Bulls	Bulls	Bulls	Bulls	
Method of feeding	Group	Group	Group	Group	
Number on test	9	12	6	2	29
Average age on test	190	182	192	188	188
Initial weight	432	453	444	478	452
Initial score:					
Condition	3	2-	2	2+	
Conformation	3+	2	2-	1-	
Days on test	158	168	168	168	168
Average daily gain	2.36	2.18	2.42	2.55	2.38
Feed efficiency:					
Grain per 100# gain	500	556	484	456	499
Final weight	829	820	850	909	852
Final score:					
Conformation	80	83	81	86	83

Montana Agricultural Experiment Station

Miles City Control - Havre

Cow Production Data - 1966 calf crop

Sire	226	270	265	280	207	250
Number cows bred to calve:						
As 2-yr.-olds	1	1	1	2	3	2
At 3 yr. and up	14	16	14	15	14	16
Number calves born from:						
2-yr.-olds - Alive	1	0	1	1	3	2
- Dead	0	0	0	0	0	0
3-yr.-olds and up - Alive	9	11	13	14	13	12
- Dead	0	2	0	0	0	0
Number calves weaned	10	11	14	15	16	14
Percent calf crop: ^a						
Born	56.6	76.4	93.3	88.2	94.1	77.7
Weaned	56.6	64.7	93.3	88.2	94.1	77.7

^aCalves born or weaned/number cows exposed

Preweaning Performance - 1966 calf crop

Birth weight - Bulls	84	85	84	87	75	77
- Heifers	80	74	78	74	74	77
Weaning age - Steers	184	170	174	169	175	182
- Heifers	177	180	177	178	174	164
Weaning weight - Steers	476	426	453	435	432	453
- Heifers	440	428	418	450	382	394
Adjusted weaning weight: ^b - Steers	468	451	465	456	440	448
- Heifers	445	428	424	457	392	424
Weaning score:						
Conformation - Steers	2+	2+	1-	1-	2	2
- Heifers	2+	2+	1-	1-	2	2
Condition - Steers	2+	2+	2+	2+	2+	2+
- Heifers	2+	2+	2+	2+	2+	2+

^b180-day weight

Montana Agricultural Experiment Station

Havre

Postweaning Performance - 1965 calf crop

Breed	Hereford	Hereford	Hereford
Line	HL 1	HL 2	HL 3
Sire	942	730	39
Sex	Bulls	Bulls	Bulls
Method of feeding	Group	Group	Group
Number on test	4	6	3
Average age on test	190	182	192
Initial weight	436	445	411
Initial score:			
Condition	3	2-	2
Conformation	3+	2	2-
Days on test	267	268	268
Average daily gain	2.32	2.28	2.35
Final weight	1056	1056	1040

Carcass Data

Fat thickness - 12th rib mm	71	58	71
Rib-eye area - sq. in.	12.00	14.92	13.18
Carcass weight	592	594	614
Tenderness	11.09	11.22	10.46
Carcass grade	16	16	16
Marble score	3	3	3

Montana Agricultural Experiment Station

Hayre

Postweaning Performance - 1965 calf crop

Breed	Hereford										Stock- yards Commer- cial
Line	MC	HL 1	HL 2	HL 2	HL 2	HL 3	HL 3	HL 3	Rancher IX	IX cow	
Sire	Control	109	270	123	136	118	158	180*	180*	HL 1	
Sex	Steers	Steers	Steers	Steers	Steers	Steers	Steers	Steers	Steers	Steers	Steers
Method of feeding	Group	Group	Group	Group	Group	Group	Group	Group	Group	Group	Group
Number on test	9	9	3	6	5	6	5	6	6	6	19
Avg. age on test	178	186	178	167	174	183	175	180*	180*	180*	180*
Initial weight	411	422	447	415	422	450	443	473	483	483	431
Initial score:											
Condition	1-	1-	2+	2+	2+	1-	1-	1-	1-	1-	2+
Conformation	2+	2	2+	2+	2+	1-	1-	1-	1-	1-	2+
Days on test	267	280	260	274	273	270	268	274	243	243	277
Avg. daily gain	2.40	2.24	2.36	2.20	2.30	2.33	2.26	2.11	2.50	2.50	2.00
Feed efficiency:											
Grain/100# gain	586	617	627	605	606	606	647	668	533	533	705
Final weight	1051	1046	1059	1016	1048	1075	1046	1050	1089	1089	982

*Approximate

Carcass data											
Fat thickness -	15.78	16.18	16.78	15.17	13.00	13.67	12.20	15.11	22.28	15.56	
12th rib											
Rib-eye area -											
sq.in.	12.19	12.01	11.67	12.34	12.54	12.20	12.34	12.73	10.88	12.03	
Carcass weight	575	590	592	573	596	609	596	596	619	550	
Tenderness	4.63	5.75	4.90	5.02	5.55	5.05	6.94	6.51	5.76	4.84	
Carcass grade	12	11	12	12	12	12	10	12	13	12	
Marble score	6	5+	5+	5	6	6	6+	5+	5+	5+	

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

- I. Station: U. S. Range Livestock Experiment Station, Miles City, Montana
- II. Project titles: 1. Breed crossing for increased production in beef cattle. 2. Development of superior lines of beef cattle. 3. A study of response to selection and genetic-environmental interaction in genetically similar groups of Hereford cattle at two locations.
- III. Personnel:
 - Experiment Station:
 - U. S. Range Livestock Experiment Station, Miles City, Montana
 - O. F. Pahnish, Project Leader, J. J. Urick, R. A. Bellows, T. M. Riley, R. B. Gibson, D. C. Anderson
 - Montana Agricultural Experiment Station, Bozeman
 - R. L. Blackwell, F. S. Willson, A. E. Flower, and N. A. Jacobsen
 - U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
 - Bradford W. Knapp, Acting Investigations Leader
- Cooperators:
 - U. S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland
 - E. J. Warwick, Chief, Beef Cattle Research Branch
 - Brooksville, Florida
 - W. C. Burns, Superintendent, West Central Florida Experiment Station
 - Florida Agricultural Experiment Station, Gainesville
 - Marvin Koger
- IV. and V. Nature and extent of work done this year with summary of progress and conclusions

Breed Crossing for Increased Production: Phase 1:

A manuscript covering the preweaning and weaning traits in this phase of the experiment was prepared for publication. Calves produced in this phase were first crosses obtained from matings among the Hereford, Angus, and Charolais breeds. Data on calves obtained by mating Hereford, Angus, and Charolais bulls to Brown Swiss cows were included as an addition to the main study. Analyses were run with data on the Brown Swiss crosses omitted to estimate heterosis and again with these data included for a study of the effects of Brown Swiss breeding.

All preweaning and postweaning data on this phase of the study have been collected. These data are used to estimate heterosis in two-breed crosses.

Effects of the Hereford, Angus, and Charolais breeds on preweaning and weaning traits when functioning as breed of sire and as breed of dam were studied. The results are summarized in table 1. Average performance of the three breeds as straightbreds and in crosses enter into the comparisons shown.

Table 1. Differences in Performance of Each Breed Functioning as Sire and as Dam^a

Breed of sire or dam within sex of calf	Birth weight	ADG birth to weaning	Weaning wt. 205-day	Weaning score ^b
	lb.	lb.	lb.	units
Steer calves:				
Hereford	-4.9**	0.06	8	0.3
Angus	-0.7	0.06	12	1.1**
Charolais	5.5**	-0.13**	-20*	-1.4**
Heifer calves:				
Hereford	-4.1**	0.01	-3	0
Angus	-1.1	0.02	3	0.8
Charolais	5.5**	-0.03	0	-0.8*

^aDifferences are breed-of-sire $\bar{x}$ minus breed-of-dam $\bar{x}$

^bWeaning scores are on 100-point basis with 100 being highest score

* $P < .05$, ** $P < .01$ applies to differences between functions within breed

In general, the Charolais breed was the growthiest of the three beef breeds as represented in this study. Within the Charolais breed (table 1), the Charolais produced heavier calves at birth when functioning as breed of sire. Conversely, the Charolais as breed of dam produced faster gaining and heavier weaning calves, but differences were significant only when based on performance of male progeny. Calves from Charolais dams scored somewhat higher at weaning than did calves by Charolais sires.

Calves from Hereford dams were heavier at birth than calves by Hereford sires. Male calves by Angus sires scored higher than male calves by Angus dams. With these exceptions, each of the British breeds performed similarly as breed of sire and as breed of dam.

Estimates of heterosis (advantage of cross over midparent) are summarized in table 2. In most of the crosses listed, and in the overall, heterotic effects on the traits studied were higher for steers than for heifers. In only a few cases did the average of crossbred heifers exceed the midparent average by a significant amount.

Although the results are not shown in table 2, differences between reciprocal crosses were subjected to the standard t test. The CxH steers and heifers were heavier at birth than the HxC steers and

Table 2. Crossing Advantage by Breed-of-Sire x Breed-of-Dam Groups Within Sex of Progeny

Breed ^a Sire Dam	Birth weight				ADG birth to weaning				Weaning weight 205 days				Weaning score			
	Steers		Heifers		Steers		Heifers		Steers		Heifers		Steers		Heifers	
	Mid- parent		Mid- parent		Mid- parent		Mid- parent		Mid- parent		Mid- parent		Mid- parent		Mid- parent	
	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%
H A	74.1	5.1	73.0	-1.5	1.82	7.7*	1.80	2.3	450	6.9**	441	1.8	78.8	1.5*	79.4	-.5
A H	74.1	6.9*	73.0	2.1	1.82	4.9	1.80	4.2	450	5.3*	441	1.8	78.8	1.7*	79.4	0.3
H C	85.6	-3.2	82.0	-3.9	2.01	7.0*	1.96	2.3	498	4.9*	483	1.3	78.2	3.2**	79.0	0.8
C H	85.6	11.0**	82.0	8.6**	2.01	-.2	1.96	-.6	498	1.8	483	1.2	78.2	1.8*	79.0	-.3
A C	82.0	0.3	78.1	-2.3	2.07	6.6**	2.00	2.3	509	5.6*	487	1.6	79.4	4.1**	79.6	2.1*
C A	82.0	4.4*	78.1	4.8*	2.07	-4.1	2.00	1.0	509	-2.7	487	1.7	79.4	0.3	79.6	0
All crosses	80.1	4.2**	77.8	1.4	1.98	3.6*	1.92	1.9	485	3.6**	472	1.8	78.8	2.1**	79.3	0.4

^aHereford, Angus, and Charolais are H, A, and C, respectively

*P < .05 and **P < .01 refer to significance of difference ($\bar{x}$ cross minus $\bar{x}$ midparent)

heifers ($P < .01$). The CxA heifers were heavier at birth than the AxC heifers ($P < .05$). The HxC and the AxC steers gained faster from birth to weaning than did the reciprocal crosses ($P < .05$ and $P < .01$, respectively). The AxC steers were heavier at weaning than the CxA steers ($P < .05$). The AxC steers and heifers scored higher at weaning than did the reciprocal crosses ($P < .01$ and $P < .05$, respectively). All other differences between reciprocal crosses were nonsignificant.

The most promising cross in several respects, based on results of this study, was obtained by using Angus bulls on Charolais females. The AxC calves exceeded all other crosses of the beef breeds in preweaning gain and weaning weight and most nearly equaled the average gain and weight of the straightbred Charolais calves, the growthiest straightbred calves in this study. The AxC calves exceeded the straightbred Angus calves which were the highest scoring straightbred calves. In addition, the average birth weight of the AxC calves was moderate, being influenced little by heterosis.

In the study of effects of Brown Swiss breeding, Brown Swiss cows were bred to Hereford, Angus, and Charolais bulls. The HxB, AxB, and CxB crossbred progeny were compared. In addition, each of these crossbred groups was compared with crossbreds by the same sires and out of dams of the other beef breeds. The CxB calves excelled the HxB and AxB calves in birth weight and generally in weaning weight. Although the CxB crossbreds gained somewhat faster than the other two groups from birth to weaning, the differences were largely nonsignificant. Differences in weaning scores among the three groups of Brown Swiss crossbreds were unimportant.

Hereford, Angus, and Charolais sires produced crossbred calves that were (in most cases) significantly heavier at birth and growthier to weaning when bred to Brown Swiss cows than when bred to cows of the beef breeds used in the study. Brown Swiss breeding in crosses was consistently associated with some reduction in weaning grade as indicated by comparisons with crossbreds of beef breeding only. This reduction, perhaps, would be of minor importance as the mean weaning scores of all crossbred groups were within the choice feeder grade.

Phase 2:

This phase of the crossbreeding study is designed to evaluate maternal qualities of crossbred females (two-breed crosses of the Hereford, Angus, and Charolais breeds). Records on two crops of calves (1965 and 1966) show no maternal advantage in preweaning growth of calves from crossbred females of beef breeding. Crossbred females with Brown Swiss breeding (HxB, AxB, and CxB) did produce calves averaging 30 to 50 pounds heavier at weaning than calves produced by crossbred females of the beef breeds or straightbred females of the three beef breeds. Records to date indicate that the calving percentage at weaning for crossbreds of beef breeding may be at least 4 to 8 percentage points higher than for straightbreds of the beef breeds. Calving percentages at weaning of crossbred females with Brown Swiss breeding have been quite erratic over the two-year period, rendering comparisons

with other groups rather difficult at this time. Relatively small numbers of crossbred females with Brown Swiss breeding may contribute to the fluctuation noted.

Phase 3:

The primary objective of this phase of the project is to determine to what extent hybrid vigor can be realized and maintained through two-way and three-way rotational crossing of the Hereford, Angus, and Charolais breeds. Weaning data on one crop of calves (1965) are available to date. The progeny fall into bull, steer, and heifer classes. A random half of the bulls within breeding groups are steered at the end of the calving season.

Crossbred bull and heifer calves averaged heavier than the straightbreds of the beef breeds at birth and weaning. The crossbreds also scored higher, but all mean scores were within the choice feeder grade. The two-breed crosses in the steer class averaged lighter in weight than the straightbreds at birth and weaning.

To date, three-breed crosses of the beef breeds show some advantage over two-breed crosses and straightbreds in preweaning growth and weaning score.

Crossbred calves with Brown Swiss breeding showed the usual growth advantage over straightbreds or crosses of the beef breeds, the dams of these calves all being 50 percent Brown Swiss. On the other hand, the calving percentage for the Brown Swiss crossbred cows used in phase 3 was only 44.4 percent based on total calves born.

Development of Superior Lines of Beef Cattle:

This project is currently undergoing revision.

Development of Inbred Lines:

A history of the development and a summary of the performance of 14 inbred lines of Hereford cattle developed on the station from 1934 through 1961 has been published as a Montana Agricultural Experiment Station bulletin.

A test of progress made in selection of Line 1 cattle was started in the breeding season of 1965. Semen from five Line 1 bulls was used on grade Hereford females in the breeding seasons of 1965 and 1966. The semen was collected from two bulls dropped in 1953, one bull dropped in 1955, one bull dropped in 1961, and one bull dropped in 1965. The first calves in this study were born in 1966. Progeny averages were as follows:

<u>Calf traits</u>	<u>Sires born</u>	
	<u>1953-55</u>	<u>1961-63</u>
Birth weight - lb.		
Males	81	87
Females	76	85
Weaning weight (180-day) - lb.		
Steers	347	372
Heifers	334	394
Weaning scores - units		
Steers	77	79
Heifers	77	81

Selection for Carcass Traits:

This study is continuing as outlined in the project plan. Possibilities of using the accumulated carcass data in a study contemplated by a graduate student at Colorado State University is under consideration.

Crossline Study: Phase 1.

This study was designed mainly to measure the amount of hybrid vigor from crossing Lines 1, 4, 6, 9, and 10. Postweaning data on four calf crops, totaling 455 head, were collected and analyzed. Classification of least squares means by line-of-sire and line-of-dam provide information on characteristics of various lines. The data were analyzed separately for bulls and heifers.

Analysis of bull data: Generally Line 1 ranked above average by both line of sire and line of dam for all weights and gain. Line 6 ranked above average by line of dam for initial weight and much of this advantage was carried through to the final weight, whereas by line of sire it was well below average. Line 4, contrary to Line 6, was high by line of sire but low by line of dam. The line-of-dam means for 196-day gain rank similar to the line-of-sire means for all growth traits within lines.

Of 20 crosses, 19 showed positive crossline advantage over the midparent mean for all weights during the test period. For the 196-day gain, 15 of 20 crosses showed a crossline advantage. The overall line-cross and straightline means, differences, and percent heterosis for various traits are shown in table 3.

The linecross bulls were superior over the straightline bulls for all weights with the differences being significant in each case. The amount of heterosis of the linecross bulls was less for the 196-day feedlot gain than for the various weights, as shown in table 3. The greatest amount of heterosis in the bulls was for the initial feedlot period weight (6.3%) and then diminished to 4.4 percent at the final weight. The advantage of the crossline bulls during the feed test period was only 2.9 percent.

Table 3. Linecross and Straightline Least-squares Means, Differences, and Percent Heterosis for Postweaning Bull Weights and Gains

Gain	186-day weaning weight	Initial weight	Period 5 weight 140-days	Final weight on test 196-day period	196-day gain
	lb.	lb.	lb.	lb.	lb.
Linecross	420.5	422.7	788.7	972.0	549.0
Straightline	400.4	397.8	751.5	931.4	533.6
Difference	20.1	24.9	37.2	40.6	15.4
Percent heterosis	5.0**	6.3**	5.0**	4.4**	2.9*

*P < .05.

**P < .01

Analysis of heifer data: Differences in weights of heifers by line of dam in the early states of growth was less apparent than for the bulls, while at the later states the differences were larger as compared to the bulls. As in the case of the bulls, Line 1 ranked above the average for most growth traits by both line of sire and line of dam. For 18-month weight of heifers off the summer range the ranking of lines by both line of sire and line of dam was nearly the same as the ranking of sires by final weight of bulls off feedlot test.

Similar to the bulls, 19 of the 20 linecross groups showed an advantage over the mean of the midparent average for all weights. All 20 linecross types showed positive advantage over midparent means for 18-month score.

Table 4. Linecross and Straightline Least-squares Means, Differences, and Percent Heterosis for Postweaning Heifer Weights and Gains

	188-day weaning weight	12- month weight	18- month weight	Gain W-12	Gain W-18	Gain 12-18	18- month score
	lb.	lb.	lb.	lb.	lb.	lb.	unit
Linecross	398.6	513.1	751.7	114.4	353.0	238.6	79.7
Straightline	364.9	469.6	705.4	104.5	340.7	235.9	76.2
Difference	33.7	43.5	46.3	9.9	12.3	2.7	3.5
Percent heterosis	9.2**	9.3**	6.6**	9.5*	3.6*	1.1	4.6**

*P < .05

**P < .01

The overall average of the linecross heifers (table 4) showed a greater advantage over the straightlines than did the crossline bulls. As shown in table 4, the advantage of the linecross heifers over the straightlines for weaning weight was 9.2 percent; 12-month weight, 9.3 percent; 18-month weight, 6.6 percent; and 18-month score, 4.6 percent. Although the difference in weight between the linecross and straightline

heifers increased to 18 months of age, the percent heterosis decreased almost one-third from 12 to 18 months.

The heifers showed more heterosis than the bulls at all ages, with the greatest difference being expressed in weaning weight. The heifers showed 9.2 percent and the bulls 5.0 percent heterosis.

Phase 2:

This study is designed primarily to compare the maternal ability of straightline and crossline dams. Preweaning and postweaning data have been collected on the first two calf crops produced in this study. Two more calf crops will be produced in this phase with the final calves being dropped in 1968 and their growth periods completed in 1969.

Limited data so far from this phase show that the crossline heifers weaned heavier bull calves (this advantage was 32 pounds in 1966) than the straightline heifers, but there was no difference in weights of the heifer calves from the two groups of heifers. These results compare closely with those from phase 1 where the line-of-dam influence on weaning weights of bulls was greater than for the heifers.

Phase 3:

The first matings of this phase were made in 1966. Phase 3 is designed to compare straightbreds with two-way and three-way crosses and with a synthetic variety. Lines 1, 4, 6, and 10 from Phase 1, and the linecross heifers produced in Phase 1 and having produced two calf crops in Phase 2, make up the initial animals of Phase 3.

Straightline bulls are bred to straightline and crossline dams to produce straightbred, two-way, and three-way crosses. The synthetic variety was initiated in 1967 with mating of a crossline bull (4x1) on two-way cross females. As the synthetic variety becomes established the replacements will become available from the line itself.

The first calves from Phase 3 were dropped in 1967. This phase is to continue for an indefinite period of time. Data from several years will be needed to evaluate the merit of each of the four mating systems.

Genetic-environmental Interaction:

This project is continuing at the Miles City station and at the station at Brooksville, Florida, as outlined in the long-range plan. Information of the type for which the project was designed is not yet available. Comparisons of calves descending from foundation stock originating at Brooksville with calves descending from foundation stock originating at Miles City (Line 1) have continued.

Comparisons of the Brooksville and Miles City cattle at the Miles City location were summarized in the last annual report. In agreement with that report, progeny from the herd of Miles City origin continue

to be growthier than the calves from the herd of Brooksville origin from birth through the postweaning feedlot test of 196 days. There has been little evidence of change in relative performance of these two groups of cattle through the 1966 calf crop.

V. Application of findings:

Increasing interest in crossing as a method of improving beef production or efficiency of production is apparent. Results from the crossbreeding and linecrossing studies aid materially in providing information desired by the beef cattle industry.

The herd used in the search for methods of improving carcass traits through live animal selection is showing promise. Any effective methods of evaluating carcass merit in breeding stock will assist the beef cattle industry appreciably.

Information concerning importance of genetic-environmental interactions will help to determine whether the present free interchange of breeding stock among decidedly different environments should be in any way modified for the benefit of the beef cattle industry.

VII. Work planned for the future:

Complete the analysis and publication of Phase 1 data from the crossbreeding and linecrossing studies. This will include accumulated carcass data. Phase 2 of each study for the evaluation of maternal qualities in crossbred and linecross females and Phase 3 of each study for the evaluation of the merits of crossing systems will be continued.

Conclude the test of genetic progress made in Line 1 and undertake a similar test of Line 10 at the beginning of the 1967 breeding season.

Continue the carcass and genetic-environmental interaction studies as outlined in the project plans. Cooperate with Colorado State University in making data from the carcass project available if it is of the type desired for a contemplated thesis problem.

Continue cooperation with the Montana Agricultural Experiment Station in a study of genetics of certain protein components in milk from beef cows. The work will be done by a graduate student under direction of personnel at Montana State University. Milk samples from cows in Phase 2 of the crossbreeding and linecrossing studies were taken in October 1966. Collection of additional samples in October 1967 is contemplated.

VIII. Publications and manuscripts:

Anderson, D. C. and R. A. Bellows. 1967. Some causes of neonatal and postnatal calf losses. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:15-20.

Bellows, R. A., R. B. Gibson, T. M. Riley, and D. C. Anderson. 1967.
Pelvic area and body size relationships in Hereford heifers.
Manuscript submitted to Journal of Animal Science.

Brinks, J. S., J. J. Urick, O. F. Pahnish, B. W. Knapp, and T. M. Riley
1967. Heterosis in preweaning and weaning traits among lines of
Hereford cattle. J. Anim. Sci. 26:278-284.

Pahnish, O. F. 1966. A look at some effects of breed crossing on beef
cattle productivity. Montana Beef Prod. School Proc. 36-47.

Pahnish, O. F., J. S. Brinks, J. J. Urick, B. W. Knapp, and T. M. Riley
1967. Heterosis in preweaning and weaning traits from crossing
beef x beef and beef x dairy breeds. Manuscript prepared for
Journal of Animal Science.

Urick, J. J., J. S. Brinks, O. F. Pahnish, B. W. Knapp, and T. M. Riley
1967. Heterosis in preweaning traits among lines of Hereford
cattle. J. Anim. Sci. (In press)

IX. Project summary:

United States Range Livestock Experiment Station

Cattle Inventory - June 1967

Breed	Hereford							Flor-
Line	L 1 ^a	L 4	L 6	L 9	L 10	L 12	L 14	ida
Purebred or grade	PB	PB	PB	PB	PB	PB	PB	PB
Bulls (12 mo. or over)	25	8	7	3	9	10	13	15
Cows (2 yr. or over)	124	21	28	28	25	53	56	46
Heifers (yearlings)	32	6	10	13	9	20	15	14
Calves:								
Bulls	47	5	9	10	10	12	18	11
Heifers	34	7	11	13	8	14	15	17

Cattle Inventory - Continued

Breed	Here- ford	Here- ford Line- ^b	Cross- bred ^c	Angus	Charo- lais	Here- ford	Angus	Charo- lais
Line		cross					Purchased	
Purebred or grade	Grade	PB	Grade	PB	PB	PB	PB	PB
Bulls (12 mo. or over)	15	39	15	3	2	4	4	7
Cows (2 yr. or older)	224	137	159	20	30			
Heifers (yearlings)	86	41	72	1	4			
Calves:								
Bulls	17	56	43	3	7			
Steers	45		65	3	5			
Heifers	71	56	103	8	9			

^aIncludes animals from Genetic-Environmental Interaction project

^bAll linecross animals resulting from crosses of Lines 1, 4, 6, 9, and 10 in Phase 1, and from crossline matings in Phase 2 and Phase 3

^cAll crossbred animals resulting from crossing of Angus, Hereford, Charolais, and Brown Swiss breeds in Phase 1, and from crossbred matings of Phase 2 and Phase 3

United States Range Livestock Experiment Station

Cow Production Data - 1966 calf crop

Breed	Hereford	Hereford	Hereford	Hereford
Line	L 1	L 4	L 6	L 9
Number cows bred to calve:				
At 3 yr. and up.	42 ^a	25 ^b	28 ^c	37 ^d
Number calves born from:				
3-yr--olds and up - Alive	23	12	18	26
- Dead	0	0	1	1
Number calves weaned	23	12	18	23
Percent calf crop:				
Born	76.7	57.1	73.1	79.4
Weaned	76.7	57.1	69.2	67.6

Preweaning Performance - 1966 calf crop

Birth weight - Bulls	79	80	66	76
- Heifers	79	79	69	74
Weaning age - Bulls	191	172	188	183
- Heifers	192	173	183	186
Weaning weight - Bulls	408	329	376	371
- Heifers	404	298	359	350
Adjusted weaning - Bulls	390	336	363	367
weight (180 days) - Heifers	383	307	355	342
Weaning score:				
Conformation - Bulls	80	76	81	78
- Heifers	80	76	81	78

^aOne cow sold on 11-23-65; 8 cows sold on 11-2-65; 3 on 11-12-65; calf crop computed on basis of 30 remaining cows

^bFour cows sold on 11-2-65; calf crop computed on basis of 21 remaining cows

^cOne cow sold on 11-2-65; 1 on 11-12-65; calf crop computed on basis of remaining 26 cows

^dOne cow sold on 11-2-65; 1 sold on 11-23-65; 1 died on 7-2-65; calf crop computed on basis of 34 remaining cows

United States Range Livestock Experiment Station

Cow Production Data - 1966 calf crop

Breed Line	Hereford L 10	Hereford L 12	Hereford L 14	Hereford Carcass
Number cows bred to calve:				
At 3 yr. and up	31 ^a	52 ^b	50 ^c	59 ^d
Number cows born from:				
3-yr.-olds and up - Alive	17	35	37	41
- Dead	2	3	0	2
Number calves weaned	17	34	36	40
Percent calf crop:				
Born	70.4	79.2	75.5	79.6
Weaned	63.0	70.8	73.5	74.1

Preweaning Performance - 1966 calf crop

Birth weight - Bulls	93	91	76	86
- Heifers	89	87	73	77
Weaning age - Bulls	163	177	179	189
- Heifers	162	185	178	192
Weaning weight - Bulls	349	361	365	416
- Heifers	322	383	338	390
Adjusted weaning - Bulls	376	363	366	401
wt. (180 days) - Heifers	346	374	341	370
Weaning score:				
Conformation - Bulls	79	77	79	81
- Heifers	77	79	77	80

^aTwo cows sold on 11-2-65; 1 sold on 11-12-65; calf crop computed on basis of 27 remaining cows. Also, 1 cow died on 9-10-65

^bFour cows sold on 11-2-65; calf crop computed on basis of 48 remaining cows

^cOne cow sold on 11-23-65; calf crop computed on basis of 49 remaining cows

^dOne cow died on 11-29-65; 3 sold on 11-2-65; 1 sold on 11-23-65; calf crop computed on basis of 54 remaining cows

United States Range Livestock Experiment Station

Cow Production Data - 1966 calf crop

Project	Linecrossing		Crossbreeding		
	Phase 2		Phase 2		
	Hereford Straight line	Hereford Line-cross	Straight-bred dams ^a	Cross-bred dams ^b	Cross-bred dams ^c
Breeding					
Number cows bred to calve:					
As 2-yr.-olds	10	53 ^d	27	37	8
At 3 yrs. and up	18	90	27	52 ^e	11
Number calves born from:					
2-yr.-olds - Alive	6	32	17	27	7
- Dead	0	1	1	0	0
3-yr.-olds and up - Alive	9	51	19	38	8
- Dead	1	3	0	0	0
Number calves weaned:					
From 2-yr.-olds	6	30	16	25	6
From 3-yr.-olds and up	8	50	19	38	8
Percent calf crop:					
From 2-yr.-olds - Born	60.0	63.5	66.7	73.0	87.5
- Weaned	60.0	57.7	59.3	67.6	75.0
From 3-yr.-olds - Born	55.6	60.0	70.4	74.5	72.7
and up - Weaned	44.4	55.6	70.4	74.5	72.7

Preweaning Performance - 1966 calf crop

Birth weight - Bulls	75	75	71	72	80
- Heifers	71	70	66	69	66
Weaning age - Bulls	176	182			
- Steers			184	190	189
- Heifers	181	180	185	189	196
Weaning weight - Bulls	320	359			
- Steers			368	380	425
- Heifers	337	334	357	353	397
Adjusted weaning wt. (180 days) - Bulls	323	355			
- Steers			361	365	408
- Heifers	335	334	348	339	369
Weaning score:					
Conformation - Bulls	76	79			
- Steers			80	80	80
- Heifers	78	78	79	78	80

^aStraightbred H, A, and C dams

^bDams were two-breed crosses of H, A, and C breeds

^cTwo-breed crosses - H, A, or C x BS

^dOne cow sold on 9-7-65; percent calf crop computed on basis of 142 remaining cows

^eOne cow sold on 9-7-65; percent calf crop computed on basis of 88 remaining cows

United States Range Livestock Experiment Station

Cow Production Data - 1966 calf crop

Project	Crossbreeding Phase 3			
	Straight- bred dams ^a	Crossbred dams ^b		Cross- bred dams ^c
Breeding				
Number cows bred to calve:				
At 3 yr. and up	22		49	9
Number calves born from:				
3-yr.-olds and up - Alive	17		37	3
- Dead	0		1	1
Number calves weaned	16	15 ^d	19 ^e	3
Percent calf crop:				
Born	77.3		77.6	44.4
Weaned	72.7		69.4	33.3

Prewaning Performance - 1966 calf crop

Birth weight - Bulls	76	83	94	
- Steers	84	78	84	
- Heifers	76	77	78	84
Weaning age - Bulls	198	197	188	
- Steers	189	195	191	
- Heifers	188	189	193	195
Weaning weight - Bulls	384	454	437	
- Steers	400	400	418	
- Heifers	376	381	423	447
Adjusted weaning - Bulls	355	424	422	
wt. (180 days) - Steers	383	375	400	
- Heifers	364	368	401	420
Weaning score:				
Conformation - Bulls	77	82	81	
- Steers	79	80	81	
- Heifers	77	80	81	81

^aStraightbred H, A, and C dams

^bDams were two-breed crosses of H, A, and C breeds

^cTwo-breed crosses - H, A, or CxBS

^dCalves were two-breed crosses

^eCalves were three-breed crosses

United States Range Livestock Experiment Station

Cow Production Data - 1966 calf crop

Project	Genetic control			GEI study	
	AI Sires				
Breeding	Hereford	Hereford	Flor-	Hereford	
	550, 560	1220	ida	Closed	Control
	and 716	and 3313		Line 1	Line 1
Number cows bred to calve:					
At 3 yrs. and up	54 ^a	36 ^b	35 ^c	67 ^d	18 ^e
Number calves born from:					
3-yr.-olds and up - Alive	27	21	30	39	12
- Dead	0	2	1	4	2
Number calves weaned	27	19	29	36	12
Percent calf crop:					
Born	55.1	69.7	93.9	70.5	82.4
Weaned	55.1	57.6	87.9	59.0	70.6

Prewaning Performance - 1966 calf crop

Birth weight - Bulls	81	87	75	83	92
- Heifers	76	85	69	76	95
Weaning age - Bulls	178	168	182	185	176
- Heifers	167	169	182	187	173
Weaning weight - Bulls			327	379	378
- Steers	346	354			
- Heifers	315	377	321	359	357
Adjusted weaning - Bulls			324	371	380
weight - 180 - Steers	347	372			
days - Heifers	334	394	316	348	363
Weaning score:					
Conformation - Bulls			75	78	78
- Steers	77	79			
- Heifers	77	81	75	77	76

^aFive cows sold on 11-2-65; computed on basis of 49 remaining cows

^bTwo cows sold on 11-2-65; one sold on 11-25-65; computed on basis of 33 remaining cows

^cTwo cows sold on 11-2-65; computed on basis of 33 remaining cows

^dFive cows sold on 11-2-65; 1 sold on 11-12-65; computed on basis of 61 remaining cows

^eOne cow sold 11-2-65; computed on basis of 17 remaining cows

United States Range Livestock Experiment Station

Postweaning Performance - 1966 calf crop

Breed	Hereford	Hereford	Hereford	Hereford
Line	L 1	L 4	L 6	L 9
Purebred or grade	Purebred	Purebred	Purebred	Purebred
Sex	Bull	Bull	Bull	Bull
Method of feeding	Group Feedlot	Group Feedlot	Group Feedlot	Group Feedlot
Number on test	10	6	8	6
Average age on test	205	188	204	202
Initial weight	404	336	359	354
Initial score:				
Conformation	80	76	81	77
Days on test	196	196	196	196
Average daily gain	2.57	2.55	2.39	2.64
Final weight	907	836	828	871
Final score:				
Conformation	77	76	76	77

Postweaning Performance - 1966 calf crop

Breed	Hereford	Hereford	Hereford	Hereford
Line	L 10	L 12	L 14	Carcass
Purebred or grade	Purebred	Purebred	Purebred	Grade
Sex	Bull	Bull	Bull	Bull
Method of feeding	Group Feedlot	Group Feedlot	Group Feedlot	Group Feedlot
Number on test	8	12	15	19
Average age on test	179	192	193	205
Initial weight	340	363	365	416
Initial score:				
Conformation	79	77	79	81
Days on test	196	196	196	196
Average daily gain	2.58	2.67	2.53	3.01
Final weight	847	886	860	1006
Final score:				
Conformation	77	76	77	80

United States Range Livestock Experiment Station

Postweaning Performance - 1966 calf crop

Project Breed	Linecrossing		Crossbreeding		
	Phase 2		Phase 2		
	Hereford ^a	Hereford ^a	Three-breed cross calves by		
	Straight-	Cross-	Straight- ^b	Cross- ^c	Cross- ^d
	line	line	bred	bred	bred
	dams	dams	dams	dams	dams
Sex	Bull	Bull	Steer	Steer	Steer
Method of feeding	Group	Group	Group	Group	Group
	Feedlot	Feedlot	Feedlot	Feedlot	Feedlot
Number on test	9	41	19	27	11
Average age on test	192	199	200	206	205
Initial weight	336	368	400	409	454
Initial score:					
Conformation	76	79	80	80	80
Days on test	196	196	196	196	196
Average daily gain	2.62	2.71	2.26	2.33	2.01
Final weight	850	899	842	866	848
Final score:					
Conformation	76	78			

^aRepresenting Lines 1, 4, 6, 9, and 10

^bStraightbred H, A, and C dams

^cDams were two-breed crosses of H, A, and C breeds

^dTwo-breed crosses - H, A, or C x BS

United States Range Livestock Experiment Station

Postweaning Performance - 1966 calf crop

Project	Crossbreeding		
Breed	Straight-bred	Phase 3 Two-breed cross ^a	Three-breed cross ^a
Sex	Bull	Bull	Bull
Method of feeding	Group	Group	Group
	Feedlot	Feedlot	Feedlot
Number on test	4	4	4
Average age on test	213	212	203
Initial weight	392	502	476
Initial score:			
Conformation	77	82	81
Days on test	168	168	168
Average daily gain	2.85	2.61	2.84
Final weight ^b	871	941	953

^aOf Hereford, Angus, and Charolais breeds

^bTest not completed

Preweaning Performance - 1966 calf crop

Project	Genetic control ^a			GEI study	
	AI - Line 1 sires				
Breeding	Hereford 550, 560 and 716 ^b	Hereford 1220 and 3313 ^c	Hereford Florida	Hereford Closed Line 1	Hereford Control Line 1
Sex	Steer	Steer	Bull	Bull	Bull
Method of feeding	Group	Group	Group	Group	Group
	Feedlot	Feedlot	Feedlot	Feedlot	Feedlot
Number on test	11	10	13	18	8
Average age on test	193	184	197	199	191
Initial weight	360	371	336	384	382
Initial score:					
Conformation	77	79	75	77	78
Days on test	196	196	196	196	196
Average daily gain	2.44	2.69	2.44	2.73	2.78
Final weight	838	898	813	919	927
Final score:					
Conformation			76	79	80

^aEstimating genetic gain by use of frozen semen from bulls of different generation intervals on grade dams

^bSires 550 and 560 born in 1953, sire 716 born in 1955

^cSire 1220 born in 1961, sire 3313 born in 1963

UNIVERSITY OF NEVADA

I. Station: Nevada Agricultural Experiment Station

II. Project titles: 1. Interaction between genotype and environment in selection for economically important traits in Hereford cattle.
2. The effect of genetic-environmental interactions on selection responses.

III. Personnel:

Experiment Station:

C. M. Bailey, Project Leader, S. P. Hammack, J. E. Hunter,
C. R. Torell

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

IV. Work done this year and summary of progress:

Selection for single characters in Hereford lines at the Main Station Field Laboratory, Reno, and at the Knoll Creek Field Laboratory near Contact, Nevada was continued. This year a total of 128 progeny were tested in individual pens at the two locations.

An analysis was made of performance data collected during the initial phase of the experiment (1955 to 1966). As expected, there were large location-sex differences in growth traits and in variation of these characters (table 1). Conformation score was similar under both sets of conditions. Although control populations were not maintained for measurement of environmental influences, the negative trends in gain and efficiency in lines at both locations (table 2) may be due, to a considerable extent, to changes in environmental factors and/or to gradual increases in levels of inbreeding. There appeared to be a close relationship in response of daily TDN intake, gain, and efficiency. Selection for single characters (gain, efficiency, or conformation) did not cause a clear-cut divergence of lines during a period of approximately two generations. At each location, response trends of heifers in lines expected to have greater genetic improvement in gain or efficiency in comparison with other lines showed the most progress (or least decline) in these characters; however, trends based on means of male progeny were not in agreement with expectation. There was a positive gradient in conformation in all lines.

Comparative slaughter trials for evaluation of body composition, feed intake, and efficiency of energy conversion of male progeny from lines at both locations were continued. A portion of the bulls from each line were slaughtered at the conclusion of the 140-day postweaning test; the remaining bulls received a fattening ration until a slaughter weight of about 1000 pounds (454 kg.) was attained. A brief summary of results for 1965 and 1966 is given in table 3. These data have not been subjected to statistical analysis; however, bulls from lines which were

Table 1. Means and Standard Deviations for Percent Inbreeding of Calf and Dam and for Performance Characteristics According to Location and Sex

Trait	Main Station				Knoll Creek			
	Bull		Heifer		Bull		Heifer	
	Mean	S.D. ^a	Mean	S.D. ^a	Mean	S.D. ^a	Mean	S.D. ^a
Inbreeding of calf, %	5.4	6.1	5.2	6.0	4.3	5.6	4.6	6.2
Inbreeding of dam, %	1.0	2.9	1.3	3.7	1.3	3.7	0.9	2.7
Age at weaning, days	235.4	13.2	235.5	14.6	230.9	15.3	230.9	17.3
Age on test, days	250.4	13.2	250.7	14.6	246.6	15.8	246.5	17.8
Weaning weight, kg.	219.0	21.4	202.4	20.2	175.4	19.7	165.7	17.4
Daily TDN intake, kg.	4.13	0.30	3.66	0.28	2.99	0.24	2.77	0.23
Gain, kg. ^b	120.0	13.1	87.6	10.1	72.8	8.6	62.1	8.1
Efficiency ^c	20.62	2.10	17.08	1.72	17.43	2.10	15.99	2.01
Conformation ^d	83.5	1.6	83.8	1.7	83.3	1.3	83.8	1.3

^aComputed within year, line

^bTotal gain during 140-day postweaning test

^cEfficiency = kg. gain/(kg. TDN ÷ 100)

^dScores from 100 (outstanding to 67 (cull))

Table 2. Selection Criteria, Number of Matings, and Progeny Tested, Annual Selection Differentials for Primary Characters and Regressions of Traits on Years According to Locations and Line (1955 - 1966)

	Main Station			Knoll Creek	
	Line 1	Line 2	Line 3	Line 4	Line 5
Selection criterion		Effi-	Confor-		Effi-
	Gain	ciency	mation	Gain	ciency
Number matings ^a	292	317	293	269	293
Number progeny tested	220	252	220	188	228
Annual selection differential					
Actual units	2.59 ^b	0.29 ^c	0.29 ^d	0.95 ^b	0.40 ^c
Standard deviation units	0.20	0.15	0.18	0.11	0.20
Regression of gain on years ^b					
Bull	-2.36	-1.33	-.45	-1.13	-1.24
Heifer	-.36	-.71	-.76	-.98	-.80
Regression of efficiency on years ^c					
Bull	-.369	-.191	-.113	-.571	-.574
Heifer	-.082	-.150	-.160	-.356	-.327
Regression of conformation on years ^d					
Bull	0.33	0.36	0.54	0.32	0.29
Heifer	0.24	0.36	0.20	0.14	0.33

^aIncludes all dams exposed to sires during the period 1955 through 1964

^bTotal gain during 140-day postweaning test, kg.

^cEfficiency = kg. gain/(kg. TDN ÷ 100)

^dScores from 100 (outstanding) to 67 (cull)

Table 3. Unweighted Means of Characteristics of Line Progeny Slaughtered Initially (Group A) or After a Period on a Fattening Ration (Group B)^a

Selection criterion	Main Station			Knoll Creek	
	Line 1	Line 2	Line 3	Line 4	Line 5
	Gain	Effi- ciency	Confor- mation	Gain	Effi- ciency
Group A:					
Number	12	10	11	9	12
Slaughter weight, kg.	306.8	321.6	326.0	247.9	243.6
Carcass weight, kg.	176.9	184.1	187.4	134.5	129.8
Area l. dorsi, sq. cm.	68.0	75.2	73.4	60.1	59.7
Carcass fat, %	15.2	14.4	17.0	9.6	10.9
Group B:					
Number	12	10	11	9	13
Initial weight, kg.	304.2	324.4	323.5	246.0	248.1
Days on feed	109	94	92	136	138
Daily gain, kg.	1.37	1.39	1.38	1.53	1.44
Hay consumed, kg.	347.9	308.4	263.1	465.8	411.0
Grain consumed, kg.	723.0	634.6	635.9	864.6	860.9
Slaughter weight, kg.	452.0	454.6	450.3	453.8	444.2
Carcass weight, kg.	278.8	276.6	277.3	273.2	268.8
Area l. dorsi, sq. cm.	87.1	85.4	88.3	82.7	81.0
Carcass fat, %	17.8	18.9	21.2	21.0	20.8

^aData were obtained in 1965 and 1966

^bPercent carcass fat = $487.5 \text{ minus } 439.8 \times \text{specific gravity of carcass.}$
Meyer et al. 1960.

under comparable conditions before the finishing period were generally similar in growth rate on a fattening ration. Progeny from the Knoll Creek Field Laboratory, which were on a lower plane of nutrition than those at the Main Station prior to the fattening phase, tended to gain faster on the fattening ration. It is interesting to observe that bulls from the gain and efficiency lines at the Main Station (Lines 1 and 2) produced somewhat leaner carcasses initially, and at the end of the fattening period, than male progeny from the line in which selection was practiced for conformation (Line 3). The final trial of this series is currently in progress.

A third set of sires from the efficiency lines at the two locations (Lines 2 and 5) was sent to San Carlos, Arizona, for use in the progeny testing program which is being conducted in cooperation with the U. S. Department of Agriculture, Arizona, Hawaii, and other states in the Western Region.

The first phase of the pilot study dealing with the effect of nutritional stress on selection response was completed. Three lines of rats were maintained on a standard diet for six generations; an additional three lines received a mixture consisting of 55 percent standard diet: 45 percent cellulose during a 6-week postweaning test (28 to 70 days of age). All animals were fed the standard diet after 70 days of

age. Progeny in two of the lines on each nutritional regimen were selected for rapid growth during the postweaning test. The other lines served as controls. Means for postweaning gain and post-test gain (70-100 days of age) are shown in the attached figures (N = 2366); diets refer to test diet, since all rats received the standard diet ad libitum during the post-test period. Preliminary observations are: (1) there was a marked difference in growth rate on the two diets during the postweaning period, (2) selection for rapid growth was effective on both diets, (3) there was indication of compensatory growth during the post-test period, (4) there appeared to be a relationship between growth rate during the postweaning and post-test periods.

The final phase of the pilot study is nearing completion. Sires from the four selected lines were mated with control dams on both diets as indicated below:

Dam	Sire			
	Regular diet		Restricted diet	
	Rep. A	Rep. B	Rep. A	Rep. B
Regular diet, control	X	X	X	X
Restricted diet, control	X	X	X	X

Two replications were conducted. Random samples of progenies were sacrificed at 28 days of age for evaluation of body composition at the beginning of the test period; littermates of these rats were fed in pairs for measurement of feed intake, then killed at the end of the postweaning test, i. e., at 70 days of age, to determine final body composition.

V. Application of findings:

Final conclusions concerning the relative effectiveness of various selection criteria under different environments will not be justified until selection has continued for an additional period. To date, selection for single characters (gain, efficiency, or conformation) has not caused a clear-cut separation of lines.

VI. Work planned for the future:

The five lines at the two locations will be continued.

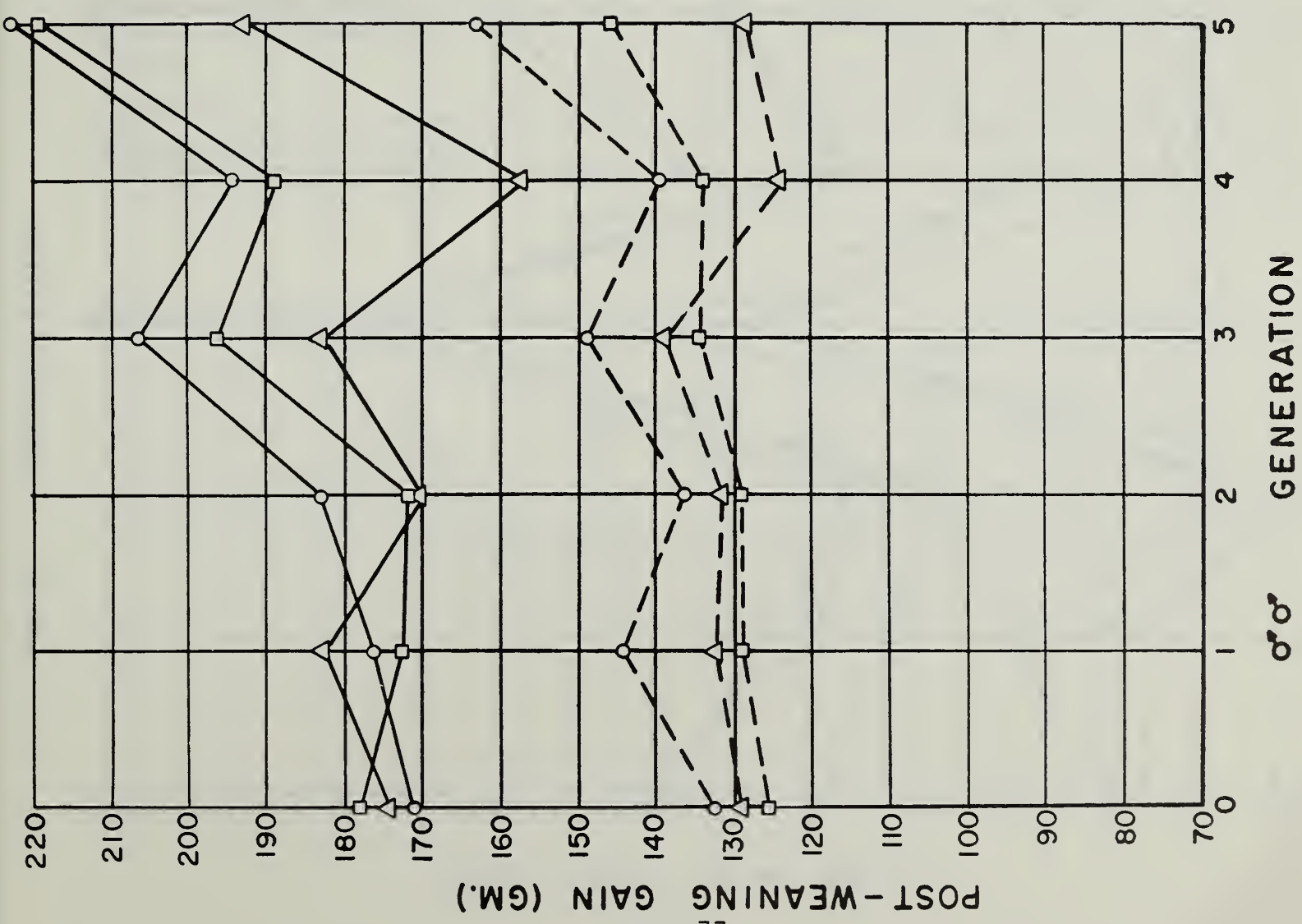
Data from the comparative slaughter trials will be analyzed.

A fourth set of sires will be entered in the regional testing program.

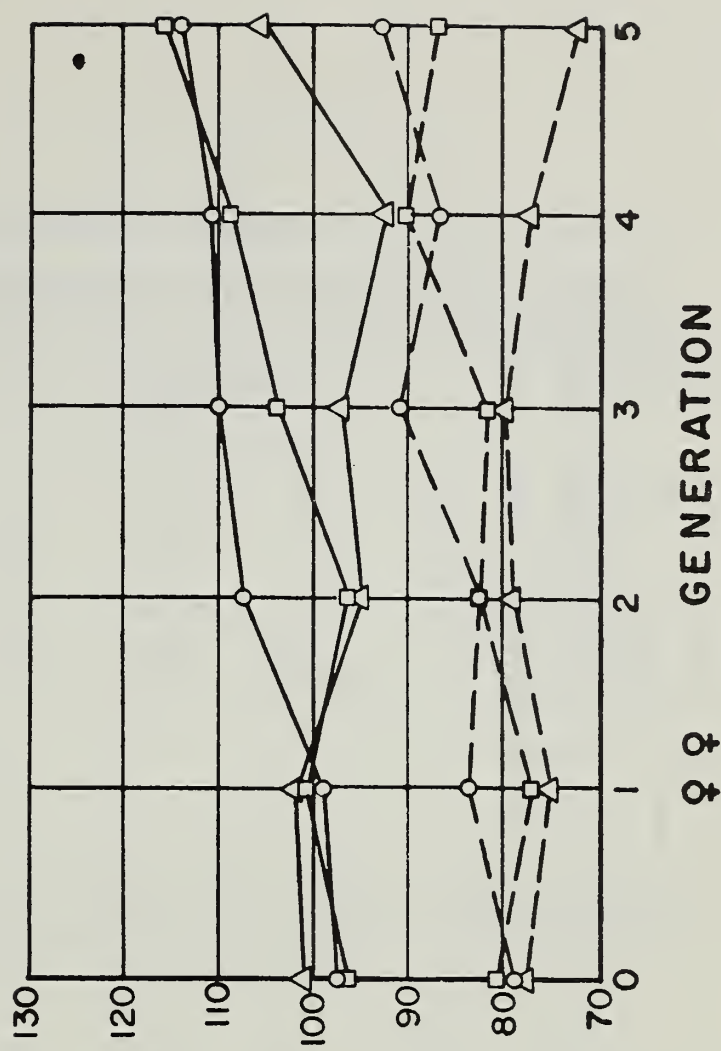
Energy determinations will be made on carcasses of rats from the pilot study, feed samples will be analyzed, and the data will be organized for statistical analysis.

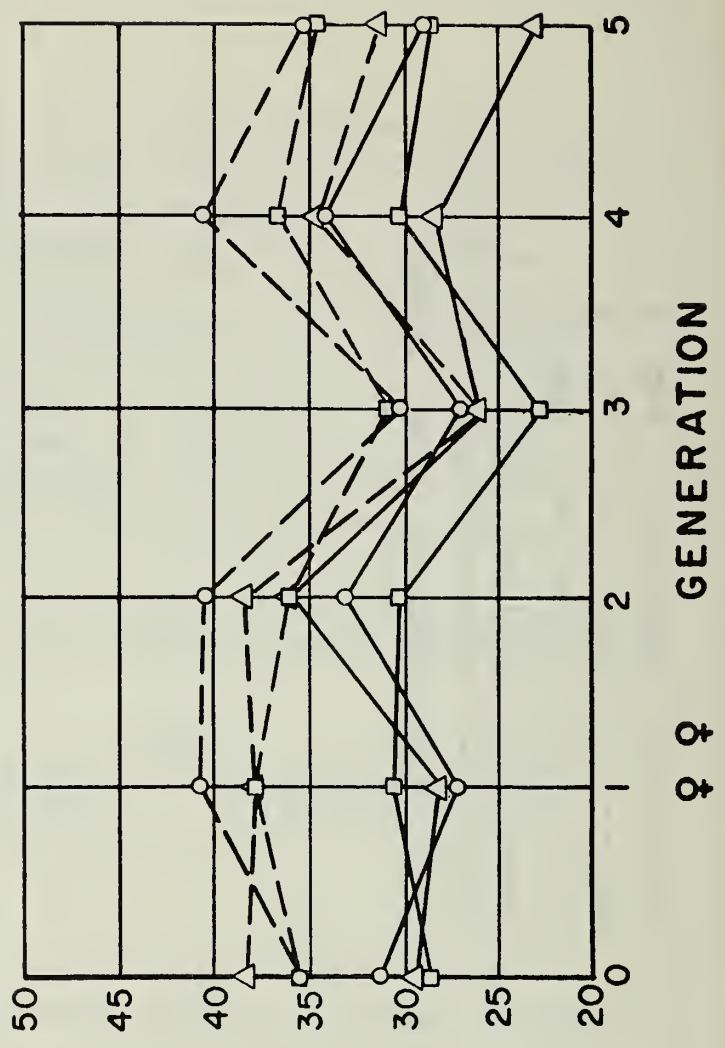
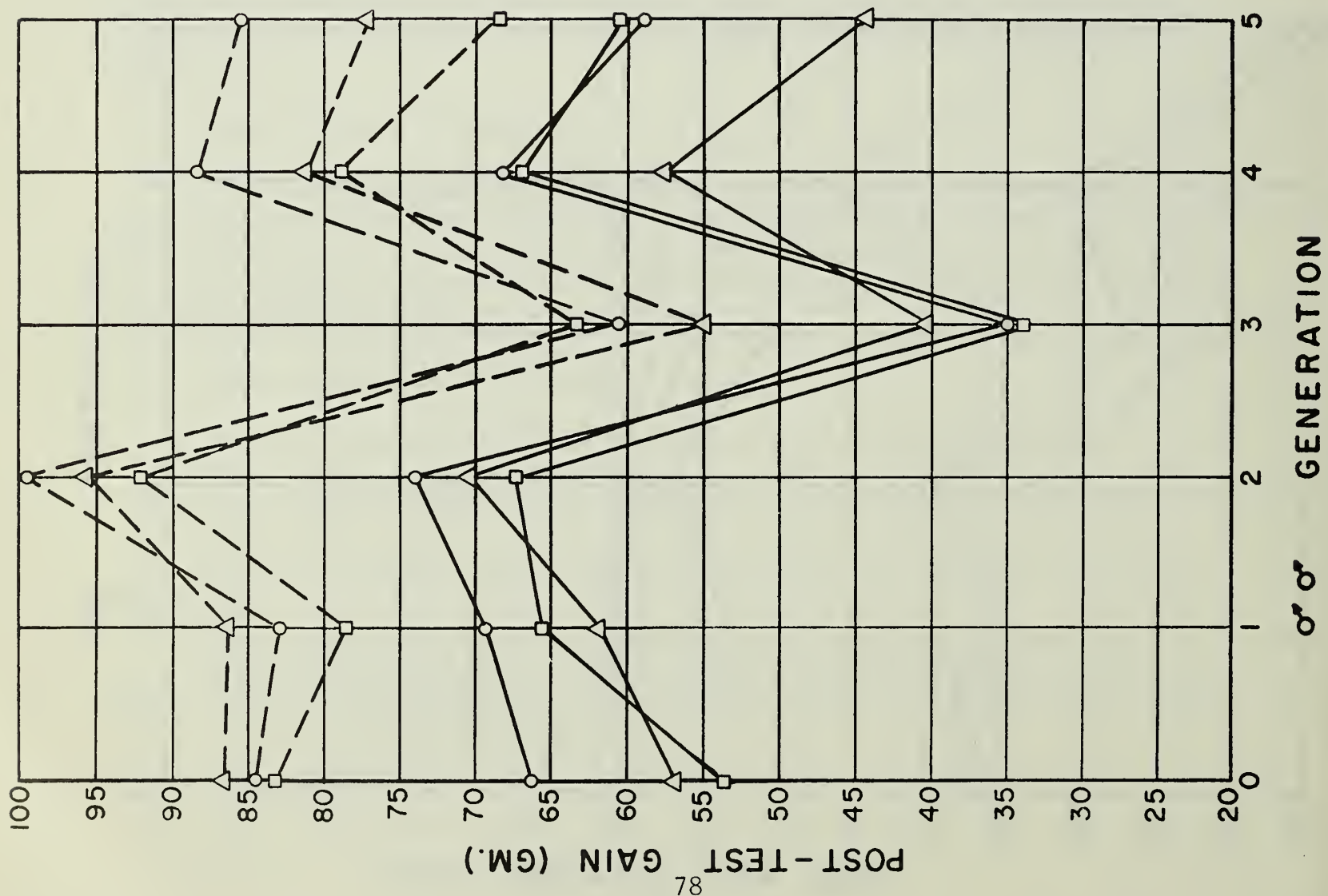
VII. Publications.

None.



○ Regular Diet, Rep. A
□ Regular Diet, Rep. B
△ Regular Diet, Control
○ Restricted Diet, Rep. A
□ Restricted Diet, Rep. B
△ Restricted Diet, Control





○ Regular Diet, Rep. A
 □ Regular Diet, Rep. B
 △ Regular Diet, Control
 ○ Restricted Diet, Rep. A
 □ Restricted Diet, Rep. B
 △ Restricted Diet, Control

IX. Project summary:

Nevada Agricultural Experiment Station

Cattle Inventory - June 1967						Total
Breed			Hereford			
Line ^a	1	2	3	4	5	
Purebred or grade			Purebred			
Bulls (12 mos. or over)	6	6	6	4	6	28
Cows (2 yr. or over)	41	42	36	36	35	190
Heifers (yearlings)	7	7	4	7	6	31
Calves - Bulls	17	15	12	13	6	63
- Heifers	12	14	12	10	5	53

^aLines 1, 2, 3 - irrigated pastures

Lines 4, 5 - range conditions

Cow Production Data - 1966 calf crop

Number cows bred to calve:						
At 3 yr. and up	34	34	33	33	34	168
Number calves born from:						
3-yr.-olds and up - Alive	32	29	26	24	27	138
- Dead	0	0	2	0	0	2
Number calves weaned	29	29	24	24	25	131
Percent calf crop: ^b						
Born	94	85	79	73	79	82
Weaned	85	85	73	73	74	78

^b
$$\frac{\text{Calves born alive/weaned}}{\text{Cows exposed to bull}} \times 100$$

Prewaning Performance - 1966 calf crop						Average
Weaning age - Bulls	225	221	218	220	212	219
- Heifers	223	221	216	216	223	220
Weaning weight - Bulls	428	437	426	333	297	384
- Heifers	395	410	341	302	310	352
Average inbreeding - Bulls	14	8	6	7	5	8
- Heifers	10	7	8	7	6	8

Nevada Agricultural Experiment Station

Postweaning Performance - 1966 calf crop						Total or Average
Breed	Hereford					
Line ^a	1	2	3	4	5	
Sex	Bull					
Method of feeding	Individual feedlot					
Number on test	15	13	16	11	13	68
Average age on test	246	242	239	241	233	240
Initial weight	438	448	440	354	316	399
Days on test	140	140	140	140	140	140
Average daily gain	2.04	2.00	1.92	1.23	1.28	1.69
Feed efficiency:						
Lb.gain/100 lb.TDN	22.9	22.6	21.5	18.1	19.7	21.0
Final weight	723	727	709	526	495	636
Final score:						
Conformation ^b	84.4	84.9	94.6	84.5	84.2	84.5
Average inbreeding	14	8	6	7	5	8

Postweaning Performance - 1966 calf crop						
Breed	Hereford					
Line ^a	1	2	3	4	5	
Sex	Heifer					
Method of feeding	Individual feedlot					
Number on test	14	13	8	13	12	60
Average age on test	244	242	237	237	244	241
Initial weight	407	422	356	319	328	366
Days on test	140	140	140	140	140	140
Average daily gain	1.45	1.46	1.41	1.07	1.08	1.29
Feed efficiency:						
Lb.gain/100 lb.TDN	17.4	17.9	17.1	17.2	17.6	17.4
Final weight	611	625	552	468	479	547
Final score:						
Conformation ^b	84.8	84.8	84.6	85.1	84.7	84.8
Average inbreeding	10	7	8	7	6	8

^aProgeny in Lines 1, 2, 3 received 2 parts grass hay: 1 part concentrate ad libitum. Lines 4, 5 received 3 pounds alfalfa pellets daily plus grass hay ad libitum.

^bScores from 100 (outstanding) to 67 (cull)

NEW MEXICO STATE UNIVERSITY

- I. Station: New Mexico Agricultural Experiment Station
- II. Project title: Inheritance of heart defects and evaluation of factors affecting production and anomalous traits in beef cattle
- III. Personnel:

Experiment Station:

L. A. Holland, Project Leader, A. L. Neumann, and E. E. Ray

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

- IV. Nature and extent of work done this year and summary of progress:

Patent Ductus Arteriosus Defect Breeding Group

Ten calves from the sire-daughter matings to test inheritance of the defect were born in the spring of 1967. One calf, dying from scours at six days of age, had a slightly patent ductus arteriosus, but a patent ductus arteriosus at this age is not considered abnormal. Including eleven calves in the 1966 calf crop, 21 calves have been produced by the sire-daughter matings and 20 are still alive and apparently normal. A normal calf from the mating of the sire and his mother was born in the fall of 1966. The sire died unexpectedly from pneumonia in September 1966. Autopsy revealed a normal heart and a normal ductus arteriosus. Six steers from the 1966 calf crop are being fed, will be slaughtered upon attaining 1000 pounds live weight, and their ductus arteriosus will be inspected.

Ventricular Septal Defect Breeding Group

Fourteen calves have been born in this group since the last W-1 report. Three of the calves died but ventricular septal defects were not observed.

Control Breeding Groups

Defective hearts and abnormal ductus arteriosus have not been observed in the old line and the outcross line which serve as controls.

Data Analysis

Analyses for three master's theses were begun and these should be completed during the fall of 1967. In the study of calving percentages and calf losses in the purebred cattle from 1933 to 1964, the following results were obtained from 999 matings:

Live calves at weaning	82.3%
No calves produced	5.5%
Abortions	2.0%
Dead calves first 24 hours (other than hydrocephalus)	5.7%
Hydrocephalus	0.7%
Deaths birth to weaning	3.7%

Chi-square analyses of effects of lines, sex, and age of cow on death losses were begun.

The other theses pertain to (1) correlations between carcass characteristics and (2) effects of years, sires, rations, and live weight upon offal of steers.

V. Application of findings:

Although all the calves from matings to test the inheritance of the ventricular defect and the patent ductus arteriosus defect have not been born, it appears that these defects are not simply inherited.

VI. Work planned for the future:

Continue project as planned.

VII. Publications and manuscripts:

Holland, L. A. and J. H. Knox. 1967. Vaginal prolapse in Hereford cows. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:27-30.

New Mexico Agricultural Experiment Station

Cattle Inventory - June 1967				Total
Breed		Hereford		
Line	Old	XL	Linecross ^a	
Purebred or grade		Purebred		
Bulls (12 mo. or over)	6	4		10
Cows (2 yr, or over)	38	14	1	53
Heifers (yearlings)	8	1	2	11
Calves - Bulls	9	3	3	15
- Steers	1	2	2	5
- Heifers	17	1	4	22

^aLinecrosses resulted from mating of Old Line bull with XL cows in the test for inheritance of the ventricular septal defect

Cow Production Data - July 1, 1965 - June 30, 1966 calf crop					
Breeding group	Old	XL	Ven- tricular	Ductus arteriosus	
Number cows bred to calve:					
As 2-yr.-olds	0	1	2	10	13
At 3-yrs. and up	10	7	20	3	40
Number calves born from:					
2-yr.-olds - Alive	0	1	1	8	10
- Dead	0	0	0	0	0
3-yr.-olds and up - Alive	7	6	18	3	34
- Dead	1	0	3	0	4
Number calves weaned	6	7	17	10	40
Percent calf crop ^b - Born	80	88	100	85	91
- Weaned	60	88	80	80	75

^bNumber calves born or weaned/number cows exposed x 100

Preweaning Performance				
Birth weight - Bulls	73	74	74	78
- Heifers	72	59	75	70
Weaning Age - Bulls	240	240	240	240
- Heifers	240	240	240	240
Weaning weight - Bulls	568	543	563	461
- Steers	469	434	500	443
- Heifers	479	389	462	392
Weaning score:				
Conformation - Bulls	7.0	7.0	6.5	6.0
- Steers	7.0	5.0	6.9	7.0
- Heifers	6.5	6.0	6.2	5.8
Condition - Bulls	13.0	14.0	11.5	12.0
- Steers	11.5	8.6	12.6	12.3
- Heifers	12.0	11.0	12.0	9.6
Average inbreeding ^c - Bulls	0.32	0.00	0.15	0.45
- Steers	0.29	0.29	0.17	0.45
- Heifers	0.27	0.49	0.22	0.44

^cAverage inbreeding is lower in ventricular septal group because some calves resulted from linecrosses

New Mexico Agricultural Experiment Station

Postweaning Performance - 1966 calf crop

Breed	Hereford
Purebred or grade	Grade
Sex	Steers
Method of feeding	Group
Number on test	29
Average age on test	225
Initial weight	385
Days on test	238
Average daily gain	2.33
Final weight	940

Fat thickness - 12th rib, cm.	1.03
Rib-eye area - sq. in	10.2
Carcass weight, lbs.	524
Carcass grade	16.4 ^a

^aEquals G+

OREGON STATE UNIVERSITY

- I. Station: Oregon Agricultural Experiment Station
- II. Project title: Diallel crossing in beef cattle and its use in breed improvement
- III. Personnel:
 - Experiment Station:
Ralph Bogart, Project Leader, Walter Kennick, A. T. Ralston, Ken Rowe, Al Anglemeir, Paul Humes, Larry Douglass, Joe Templeton, James McArthur, Dean Frischknecht, and John Landers
 - U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
Bradford W. Knapp, Acting Investigations Leader
- IV. Nature and extent of work done this year:
 1. Prepared manuscripts for three papers presented at the Western Section, American Society of Animal Science, and one technical bulletin.
 2. Collected data on suckling gains, rate and efficiency of gains, scores for conformation and condition, and body measurements from calves produced by the fourth and last diallel mating among the three inbred lines of Herefords. Blood levels of creatinine, amino acid nitrogen, and urea nitrogen levels were obtained on all heifers at 400 and 750 pounds and on all bulls at 450 and 800 pounds and all that have reached the weight of 1000 pounds, at which time they have been slaughtered.
 3. Calves have been produced from inbred and linecross cows born in 1963 and 1964. These calves were all sired by one and the same Angus bull and are used to evaluate the calf producing ability of these cows.
 4. The first calves by linecross 1 x 2, 1 x 3, and 2 x 3 cows and bulls and by linecross cows of 1 x 2, 1 x 3, and 2 x 3 groups mated by artificial insemination to 1 x 4, 1 x 10, and 4 x 10 bulls produced by the U. S. Range Livestock Experiment Station have been born and are doing well.
 5. The Angus line has been continued as a two-sire and 20-cow line.
 6. Data were obtained on the liver nicotinamide nucleotide coenzymes on all bulls slaughtered at 1000 pounds that were produced in 1964 and 1965 by the diallel mating.

7. Preliminary analyses have been made on the production data (birth weight, suckling gains, feed required per unit of gain, and postweaning daily gain) on calves born in 1963, 1964, and 1965.

8. Data were obtained on calving of cows used in the synchronization of estrus by progestogen implants.

9. Three basic studies are being done to provide information useful in developing breeding studies:

a. Eight house fly populations, four from the U.S.D.A. Entomology Research Laboratory--

- I. Isolan resistant
- II. Orlando susceptible
- III. Sevin selected
- IV. Malathion resistant

and four from Oregon State University Department of Entomology Laboratory--

- V. Dieldrin resistant
- VI. Naphthaline resistant
- VII. Milan SRS susceptible
- VIII. Orlando DDT resistant

have been combined by mating 100 virgin ♀♀ to 20 ♂♂.

I x II	————>	I II	and	II x I	————>	II I
III x IV	————>	III IV	and	IV x III	————>	IV III
V x VI	————>	V VI	and	VI x V	————>	VI V
VII x VIII	————>	VII VIII	and	VIII x VII	————>	VIII VII

These F₁ flies were mated by taking each of the four kinds and their reciprocals, 100 ♀♀ and 50 ♂♂ of each, and mating as follows:

I II III IV
II I x IV III ———> I II III IV

III IV I II
IV III x II I ———> IV III II I

V VI VII VIII
VI V x VIII VII ———> V VI VII VIII

VII VIII V VI
VIII VII x VI V ———> VIII VII VI V

These double cross flies were combined as follows using 100 ♀♀ and 50 ♂♂ of each mating type and the same number of reciprocals:

I II III IV V VI VII VIII
IV III II I x VIII VII VI V ———> I II III IV V VI VII VIII

V VI VII VIII I II III IV
VIII VII VI V × IV III II I ———> VIII VII VI V IV III II I

These two groups have been intermated for two generations. By special matings of 1 ♂ × 3 ♀ repeated 100 times from randomly drawn ♂♂ and ♀♀, the following data have been obtained, from which genetic parameters can be estimated: Egg production, pupa weight, emergence time, and adult weight.

b. Mice are being used in a selection study in which radiation is imposed each generation. There are five different closed populations, each replicated as follows:

<u>Line</u>	<u>X-irradiation</u>	<u>Selection</u>
1	100 r just before mating	Selected for litter size and 28-day wt.
2	50 r " " " "	" "
3	25 r " " " "	" "
4	not irradiated	" "
5	not irradiated	Not selected

Two generations have been produced. Line size in each line is maintained at 12 ♀♀ and 4 ♂♂ and generations are being turned over as rapidly as possible.

c. Mice are being used to compare index selection with elite selection for four traits--litter size, birth weight, 21-day (weaning weight), and postweaning growth. Two lines are selected for increases in the traits and two lines are selected for decreases in the traits under each of the two methods of selection. Also, two lines are randomly selected and serve as controls. To establish an effective index, 300 litters from 100 ♂♂ and 300 ♀♀ have been produced from which data on the four traits were obtained for estimating such parameters as heritability; genetic, environmental, and phenotypic correlations; standard deviations, and means.

V. Summary of progress and conclusions to date:

1. The data on 137 inbred and linecross calves born in 1963 to 1965, inclusive, showed that females were more variable than males in birth weight and suckling gains. There were no significant differences between the mean of any two inbred groups and their linecrosses for birth weight an suckling gains. Postweaning daily gains were generally higher and feed per unit of gain lower for linecross heifers and for linecross bulls between 450 and 800 pounds; however, the inbred bulls gained more rapidly and were more efficient between 800 and 1000 pounds than the linecross bulls. The difference between inbreds and linecrosses showing superiority of the linecrosses was more marked in the heifers than in the bulls.

2. The suckling gain records for the 1966 inbred and linecross calves did not show any advantage of the linecross calves over the inbred calves.

<u>Kind of calf</u>	<u>Number</u>	<u>Suckling gains</u>
Inbred ♂	11	1.55 lb. per day
Inbred ♀	6	1.89 lb. per day
Linecross ♂	13	1.55 lb. per day
Linecross ♀	17	1.60 lb. per day
Angus ♂	12	2.06 lb. per day
Angus ♀	7	1.82 lb. per day

3. The postweaning data for the 1965 calf crop show that both the bulls and the heifers in the linecrosses were generally superior to corresponding inbred bulls and heifers.

<u>Line</u>	<u>Sex</u>	<u>Number calves</u>	<u>Rate of gain</u>	<u>Feed efficiency</u>	<u>800 Pounds</u>	
					<u>Con-formation</u>	<u>Condition</u>
1	♂	2	3.16	586	12.42	12.25
	♀	3	1.99	883	12.78	12.50
2	♂	2	3.21	572	12.50	12.00
	♀	1	2.51	635	12.17	12.17
3	♂	4	2.75	629	11.00	10.92
	♀	1	2.70	622	11.67	12.33
1x2	♂	6	3.38	523	12.33	11.83
	♀	5	2.35	724	13.10	12.67
1x3	♂	8	3.05	602	12.00	11.58
	♀	4	2.13	788	12.29	12.29
2x3	♂	4	3.00	609	12.12	11.67
	♀	4	2.26	734	11.88	12.04
Angus	♂	6	2.77	690	12.95	12.25
	♀	11	1.93	--	12.50	12.12

The postweaning production records of the Hereford calves exceeded the records for the Angus calves.

4. The slaughter data for the bulls slaughtered in 1965 are presented in the table below. There does not appear to be marked difference between inbred and linecross Herefords. The Angus bulls had larger testes, thyroids, and pituitaries than the Herefords.

<u>Line</u>	<u>Num-ber</u>	<u>Testes weight</u>		<u>Adrenals weight</u>		<u>Thyroid weight</u>	<u>Pitu-itary weight</u>	<u>Fat %</u>	<u>Lean %</u>	<u>Bone %</u>
		<u>Left</u>	<u>Right</u>	<u>Left</u>	<u>Right</u>					
		<u>gm.</u>	<u>gm.</u>	<u>gm.</u>	<u>gm.</u>	<u>gm.</u>	<u>gm.</u>			
1	2	228.0	236.4	9.08	7.69	19.62	1.82	31.1	51.6	17.3
2	2	241.9	210.3	6.66	7.20	15.55	1.55	31.9	51.2	16.9
3	4	216.6	224.6	7.01	7.11	14.97	1.72	32.6	51.1	16.3
1x2	5	217.5	221.2	8.20	7.23	19.73	1.79	30.2	53.8	16.4
1x3	6	214.7	242.2	7.66	7.54	18.37	1.67	28.2	53.5	18.3
2x3	3	210.0	207.7	7.54	7.11	15.85	1.90	30.4	53.1	16.5
Angus	4	256.1	261.4	7.89	7.26	20.84	2.15	33.7	49.5	16.8

^aPercent fat, lean, and bone of the 12th rib cut based on physical separations

<u>Line</u>	<u>Num- ber</u>	<u>Con- formation</u>	<u>Matu- rity</u>	<u>Quality</u>	<u>USDA Grade^a</u>	<u>Rib-eye area</u> sq.in.	<u>Fat thick- ness</u> cm.	<u>Dress- ing percent</u> %
1	2	Choice	A-	Slight+	Choice	8.83	0.6	55.3
2	2	Choice	A-	Slight	Choice	11.10	1.0	55.7
3	4	Choice-	A	Slight-	Good+	10.02	1.2	56.4
1x2	5	Choice	A-	Slight-	Choice-	11.53	0.6	56.1
1x3	6	Choice-	A-	Slight-	Choice-	11.44	0.8	56.0
2x3	3	Choice	A-	Slight-	Choice-	11.24	1.0	56.4
Angus	4	Choice	A-	Small-	Choice+	9.77	1.1	57.2

^aBull grade

5. The gonadotropic content of pituitary glands from inbred lines of Angus and Herefords, and linecross Hereford cattle has been studied. A homogenate was made of individual anterior pituitary glands. This was injected subcutaneously in a series of nine 0.5 ml. injections over a span of 64 hours into immature mice. Each female mouse received a total of 50 mg. anterior pituitary, and each male mouse received a total of 25 mg. anterior pituitary. Seventy-two hours after the first injection, the mice were autopsied and the ovarian or seminal vesicle weights recorded.

This study utilized the anterior pituitaries from 22 young beef bulls produced in the Oregon State University breeding herd. The bulls were slaughtered by a commercial abattoir soon after they had attained the weight of 1000 pounds. At the time of slaughter, the pituitaries were removed, weighed, individually identified, placed in sealed 10 ml. vials, and frozen until used in this study. Six of the pituitaries were from inbred Angus bulls, the rest were Hereford bulls, two of which were bulls of the inbred Lionheart line, four were bulls of the inbred Prince line, and one the inbred David line. The remainder were from linecrosses consisting of one Lionheart-Prince, two Lionheart-David, one Prince-Lionheart, three Prince-David, one David-Lionheart, and one David-Prince. Observations of the follicle-stimulating and luteinizing hormone assay potency are as follows:

a. All 22 pituitaries possessed a significant amount of both luteinizing and follicle-stimulating hormones.

b. Comparisons between the inbred lines showed the Lionheart line to have a significantly greater follicle-stimulating hormone potency than the Angus. The Prince line had a significantly greater luteinizing hormone potency than the Angus. Since by bioassay all bulls possessed a significant amount of both hormones, these results are not interpreted as indicating that the Angus are less fertile than the Prince or Lionheart lines. On the other hand, this may indicate that the pituitaries of Angus bulls are secreting follicle-stimulating hormone at a more rapid rate than bulls of the Lionheart-Hereford linecross, and are also secreting luteinizing hormone at a more rapid rate than bulls of the Prince-Hereford linecross. It may also indicate that the pituitaries from Angus cattle have follicle-stimulating hormone and luteinizing hormone in a desirable balance even though the

quantities of each may not be high. There was no significant difference between the three inbred Hereford lines for follicle-stimulating hormone and luteinizing hormone.

c. It would be tempting to speculate that linecross bulls possess a greater potency of pituitary gonadotropin than inbred bulls. The David-Lionheart cross had a significantly greater luteinizing hormone potency than any of the inbred lines, and the Prince-Lionheart had a significantly greater follicle-stimulating hormone potency than either the Angus, Prince, or David. However, the inbred Prince line had significantly greater luteinizing hormone potency than either the Prince-David or Lionheart-David linecrosses, and the Lionheart-David also had greater follicle-stimulating hormone potency than the inbred Lionheart. In many instances there were no statistically significant differences. Also, the number of pituitaries per line were few. Therefore, although it is tempting to speculate that the potency of pituitary gonadotropin favors the linecross, this can only remain speculative until sufficient data can confirm this assumption.

d. Comparisons of linecrosses showed certain linecrosses to have significantly higher activity of pituitary gonadotropin than others. One of these is the Lionheart-Prince linecross. It was significantly higher than the other linecrosses in one, or the other, or both hormones. The reciprocal cross, Prince-Lionheart, was likewise significantly higher in gonadotropins. In fact, it was superior to all others in follicle-stimulating hormone potency and also higher than the David-Lionheart in luteinizing hormone potency.

e. This study indicates that a genetic difference exists among animals and among lines for the potency of pituitary gonadotropins. Certain inbred lines (Lionheart, for example) crossed with other inbred lines (Prince, as another example) result in linecrosses which are superior to all other linecrosses and inbreds.

6. The data on synchronization of estrus by use of progestogen implants showed that this method as used was totally unsatisfactory. Although all cows had the cervix open at time of insemination (2 and 3 days following removal of implant), practically none of them conceived from the insemination at this time. There appeared to be no harm to the cows as most of them calved from natural service at the next estrus.

7. This investigation for the first time reports information on the correlation of various forms and ratios of nicotinamide nucleotide coenzymes in the liver tissue and endocrine gland weight with various production traits. Fifty-five inbred and linecross beef bulls raised under standard management conditions and slaughtered at 1000 pounds body weight were used in the study.

Fluorometric determinations of the nicotinamide nucleotide coenzymes showed that NADH was present in lower concentration per gram of frozen liver tissue than NAD^+ , while the concentration of NADP^+ was lower than HADPH per gram of frozen liver tissue. All forms of coenzymes showed a positive significant correlation with age (at 1000

pounds body weight) and percent fat in the body. The coenzymes in the meantime also showed a significant negative correlation with percent lean in the carcass. Thyroid gland weight also showed a negative correlation with age, percent fat in the carcass, and all the coenzymes which were positively associated with age and percent fat in the carcass. Thyroid gland weight was positively correlated with the $\text{NADP}^+/\text{NADPH}$ ratio since this ratio had a negative association with percent fat in the carcass.

As age at 1000 pounds body weight increases, the amount of thyroid tissue at 1000 pounds body weight decreases and simultaneously feed per unit gain and percent fat in the carcass increase while percent lean and gain per day decrease.

No significant correlation of any kind was observed between pituitary gland weight and production traits. This was attributed to the involvement of this gland with various hormones that may have antagonistic inducing action on these coenzymes. Evidence obtained, however, indicates both hormones (STH and TSH) increase percent lean, water content, and gain per day and decrease percent fat in the carcass. Based on this evidence, a model for the action of these hormones has been developed.

Inbreeding showed a negative significant correlation with percent lean in the carcass. In the meantime, inbreeding was positively associated with total coenzymes ($\text{NAD}^+ + \text{NADP}^+$, $\text{NADH} + \text{NADPH}$). These coenzymes all have a significant negative correlation with percent lean in the carcass. Heterozygosity, therefore, seems to have a heterotic effect on growth as it increases percent lean in the carcass, whereas it shows a negative heterotic effect on coenzyme concentration in liver tissue. This seems proper since the above coenzymes have a significant negative correlation with percent lean in the carcass. High percent lean and low coenzyme levels were characteristics associated with the linecrosses while the opposite was true of inbred animals.

Lines and linecrosses showed statistically significant differences in coenzymes and production traits. This trend was also true for the average of parents compared with their offspring. Although statistically significant differences were not obtained when all inbreds of 17 and 21 percent inbreeding were compared with linecrosses, a trend indicating higher gain per day, lower feed per unit gain, and lower coenzyme levels, was noted in the linecrosses. Diallel analysis showed no general combining ability for either the coenzymes or production traits. Specific combining ability and reciprocal effects were shown to exist for various coenzymes and production traits.

VI. Application of findings:

The results from the diallel crosses are not complete; consequently, it is not possible at this point to determine the application that may be made from the findings. By the first of September of 1967 all data on the inbreds and linecrosses dealing with growth, feed

efficiency, blood, liver enzyme, endocrine, and carcass studies should be complete. At this time a summarization of the material will be made. All of the data on the calf producing ability of inbred and linecross heifers will not be obtained until 1969.

VII. Work planned for the future:

1. Continue matings of linecross bulls and heifers from the Oregon cattle to establish one line and Oregon linecross heifers with U. S. Range Livestock Experiment Station linecross bulls to establish a second line of Herefords.
2. Continue the Angus line as a two-sire line.
3. Continue to test the inbred and linecross heifers for their calf-producing abilities as two- and three-year-old cows.
4. Individually feed test all males from 450 to 800 pounds and all heifers from 400 to 750 pounds on a completely pelleted ration.
5. Gather physiological data on all calves at 450 pounds and at the end of the feed test--750 pounds for heifers and 800 pounds for bulls.
6. Analyze data on the heifers and bulls produced by the diallel matings and prepare a technical bulletin covering this study. The data to be analyzed include pre- and postweaning gains, scores, measurements, feed efficiency, chemical constituents of the blood, carcass data, and organoleptic ratings on the cooked meat.
7. Bioassay will be made using four-day-old roosters to determine androgen (testosterone) levels in testes of bulls born in 1965 and 1966 that are slaughtered. Comparison of linecross versus inbreds and among linecrosses will be made.
8. Continue the study on selection of mice under radiation stress.
9. Continue the study on selection of mice for four traits in which the index method is compared with the elite method of selection.
10. Continue the study with house flies in which ten lines will be established
 - a. Two lines selected for improvement of traits--egg production, pupa weight, shorter emergence time, and adult weight, using a selection index.
 - b. Two lines selected for improvement of the four traits mentioned in a, with one-fourth the replacement ♂♂ and ♀♀ selected for increased egg production, one-fourth selected for increased pupa weight, one-fourth selected for shorter emergence time and one-fourth for increased adult weight.

- c. Two lines selected on an index basis but in the opposite direction to those in a.
- d. Two lines selected on the elite basis but in the opposite direction to those in b.
- e. Two lines unselected.

Line size will be 4 ♂♂ and 16 ♀♀ for each line.

11. Estimate the osmotic pressure within red blood cells of beef calves at each 100-pound increment in weight to see how osmotic pressure changes with age and size and to find relationship of this with other physiological phenomena.

VIII. Publications:

- Bogart, Ralph. 1966. Inbreeding of zoo animals. Parks and Recreation. March.
- Bogart, Ralph. 1966. Performance and progeny tests: Each have their own place. Oregon Farmer. Sept. 1. p.40.
- Frischknecht, W. Dean and Ralph Bogart. 1966. Oregon specialists studying heat period synchronization. Oregon Farmer. Oct. 6. p. 26.
- North, Warren. 1966. Gonadotropins in pituitaries of inbred and line-cross beef bulls and effects of irradiation of mammalian pituitary glands on their ability to induce in vitro ovulation of frog ovaries. Ph. D. Thesis. Oregon State University. Corvallis.
- Anwar-Afghan Mohammad. 1967. Comparative values of liver nicotinamide nucleotide coenzymes, endocrine glands, and their relationships with production traits of diallel crossed beef bulls. Ph. D. Thesis. Oregon State University. Corvallis.
- Bogart, Ralph and W. D. Frischknecht. 1967. The relationship of weights, scores, and gains in growing cattle. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:309-314.
- Bogart, Ralph, J. A. B. McArthur, and Frank Hoornbeek. 1967. Performance of topcross calves sired by four bull lines. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:297-302.
- McArthur, J. A. B., Ralph Bogart and Paul Humes. 1967. Calf producing ability of cows sired by bulls from four inbred lines. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:303-307.
- Munji, Marcus Tebid. 1967. Performance of three inbred lines of Hereford cattle and their linecrosses. M. A. Thesis. Oregon State University. Corvallis.

IX. Project summary:

Oregon Agricultural Experiment Station

Cattle Inventory - June 1967

Breed	Hereford	Hereford	Hereford	Hereford
Line ^a	1	2	3	1x2
Purebred or grade	Purebred	Purebred	Purebred	Purebred
Bulls (12 mos. or over)	2	3	1	3
Cows (2 yr. or over)	7	2	3	20
Heifers (yearlings)	3	3	0	4
Calves - Bulls	2	1	1	7
- Heifers	4	1	1	9

^aLine 1 = Lionheart, Line 2 = Prince, Line 3 = David, Line 4 = Angus

Cow Production Data - 1966 calf crop

Number cows bred to calve:				
As 2-yr.-olds	2	1	1	9
At 3-yr. and up	23	24	23	6
Number calves born from:				
2-yr.-olds - Alive	1	0	0	7
- Dead	1	0	1	1
3-yr.-olds and up - Alive	16	17	14	6
- Dead	1	1	1	0
Number calves weaned	17	17	14	13
Percent calf crop ^b - Born	68.00	68.00	58.33	86.67
- Weaned	68.00	68.00	58.33	86.67

^bCalves born alive or weaned/cows bred

Preweaning Performance - 1966 calf crop

Birth weight - Bulls	76	76	72	69
- Heifers	71	72	62	66
Weaning age - Bulls	185	180	194	203
- Heifers	181	180	177	218
Weaning weight - Bulls	367	368	360	379
- Heifers	383	345	342	415
Adjusted weaning weight ^c - Bulls	398	409	376	383
- Heifers	424	383	386	394
Weaning score:				
Conformation - Bulls	11.5	11.4	11.1	
- Heifers	11.6	11.6	11.0	
Condition - Bulls	11.0	10.7	10.7	
- Heifers	10.8	11.1	10.4	
Average inbreeding - Bulls	0.0876	0.0838	0.0324	0.0
- Heifers	0.0577	0.0836	0.0000	0.0

^c205-day weight = $\left(\frac{\text{weaning weight} - \text{birth weight}}{\text{age in days}} \times 205 \right) + \text{birth weight}$

Oregon Agricultural Experiment Station

Cattle Inventory - June 1967				Total
Breed	Hereford	Hereford	Angus	
Line ^a	1x3	2x3	4	
Purebred or grade	Purebred	Purebred	Purebred	
Bulls (12 mo. or over)	4	6	5	24
Cows (2 yr. or over)	12	10	23	77
Heifers (yearlings)	6	6	4	26
Calves - Bulls	6	1	8	26
- Heifers	4	5	11	35

^aLine 1 - Lionheart, Line 2 = Prince, Line 3 = David, Line 4 = Angus

Cow Production Data - 1966 calf crop				
Number cows bred to calve:				
As 2-yr.-olds	4	2	3	22
At 3 yrs. and up	4	4	18	102
Number calves born from:				
2-yr.-olds - Alive	4	2	2	16
- Dead	0	0	0	3
3-yr.-olds and up - Alive	4	4	18	79
- Dead	0	0	0	3
Number calves weaned	8	6	19	94
Percent calf crop ^b - Born	100.00	100.00	95.24	77.87
- Weaned	100.00	100.00	90.48	77.05

^BCalves born alive or weaned/cows bred

Preweaning Performance - 1966 calf crop				
Birth weight - Bulls	70	67	67	71
- Heifers	69	60	65	67
Weaning age - Bulls	221	221	173	189
- Heifers	216	220	174	196
Weaning weight - Bulls	446	387	418	388
- Heifers	415	359	376	378
Adjusted weaning weight ^c - Bulls	419	364	483	418
- Heifers	397	339	432	399
Weaning score:				
Conformation - Bulls			11.5	11.4
- Heifers			11.2	11.4
Condition - Bulls			10.8	10.8
- Heifers			10.9	10.8
Average inbreeding - Bulls	0.0	0.0	0.1126	0.082
- Heifers	0.0	0.0	0.0998	0.037

^c 205-day weight = $\left(\frac{\text{weaning weight} - \text{birth weight}}{\text{age in days}} \times 205 \right) + \text{birth weight}$

Oregon Agricultural Experiment Station

Postweaning Performance - 1966 calf crop

Breed	Hereford						
Line	1	1	2	2	3	1x2	1x2
Sex	Bulls	Heifers	Bulls	Heifers	Bulls	Bulls	Heifers
Method of feeding	Individual Feedlot						
Number on test	2	3	4	3	5	4	4
Average age on test	233	173	230	195	239	203	203
Initial weight	454	404	456	408	461	459	403
Initial score:							
Conformation	11.9	11.5	12.2	12.4	11.3	11.5	11.4
Condition	11.2	10.5	11.3	11.6	10.7	10.8	10.8
Days on test	123	161	117	166	121	109	159
Average daily gain	2.89	2.23	3.02	2.15	3.00	3.22	2.31
Feed efficiency:							
TDN/100 lb.gain	431	534	365	491	391	359	497
Final weight	804	874	807	762	818	808	767
Conformation	12.4	12.7	12.7	12.7	11.5	12.6	12.5
Condition	12.1	12.7	12.1	12.4	11.5	12.1	12.4
Average inbreeding	0.2630	0.1924	0.2092	0.1672	0.2119	0.0	0.0

Carcass - 1965 calf crop

Number	2	2	4	5
Fat thickness				
12th rib - cm.	0.6	1.1	1.2	0.6
Rib-eye area-sq.in.	8.83	11.10	9.90	11.53
Carcass weight	551	528	549	558
Cutability-% lean	51.62	51.20	51.15	53.84
Carcass grade ^a	Choice	Choice	Good+	Choice-
^a USDA bull grade				

Oregon Agricultural Experiment Station

Postweaning Performance - 1966 calf crop							Total
Breed	Hereford				Angus		
Line	1x3	1x3	2x3	2x3	4	4	
Sex	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	
Method of feeding	Individual Feedlot						
Number on test	4	6	4	6	12	7	64
Average age on test	218	198	221	217	188	193	202
Initial weight	454	405	460	399	456	402	432
Initial score:							
Conformation	11.1	11.3	11.0	10.9	11.5	11.2	11.4
Condition	10.7	10.8	10.5	10.5	10.8	10.9	10.8
Days on test	117	153	119	149	126	162	137
Average daily gain	3.11	2.29	2.97	2.44	2.85	2.17	2.66
Feed efficiency:							
TDN/100 lb.gain	419	501	370	463	443	534	449
Final weight	817	752	813	761	812	758	788
Final score:							
Conformation	12.2	12.3	11.6	12.2	12.7	12.3	12.3
Condition	12.0	12.4	11.8	12.2	12.4	12.3	12.2
Average inbreeding	0.0	0.0	0.0	0.0	0.1126	0.0998	0.0867

Carcass Data - 1965 calf crop				
Number	6	3	4	26
Fat thickness				
12th rib- cm.	0.8	1.0	1.1	0.9
Rib-eye area-sq.in.	11.44	11.24	9.77	10.71
Carcass weight	544	551	556	549
Cutability-% lean	53.44	53.07	49.50	52.28
Carcass grade ^a	Choice-	Choice-	Choice+	Choice-

^aUSDA bull grade

UTAH STATE UNIVERSITY

- I. Station: Utah Agricultural Experiment Station
- II. Project title: The development of breeding techniques and selection criteria for improvement of economically important characteristics in beef cattle
- III. Personnel:

Experiment Station:

J. A. Bennett, Project Leader, Keith Mikesell, Junior Nyman,
and Wm. J. Nay, Jr.

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

- IV. Nature and extent of work done this year:

The two Hereford and one Shorthorn lines were propagated as straight line cattle for the production of the 1966 calf crop and similar matings have been set up for the 1967 season. Procedures followed were similar to past years and the regular birth, weaning, and post-weaning data were collected.

One bull from the Hereford I line was sent to Arizona to be used in the cooperative progeny test studies with the San Carlos and the Hawaii herds.

As part of carcass evaluation studies, cooking tests with standing rib roasts were conducted on representatives of three sire groups. Significant differences were found among sire groups for flavor and acceptability but not for tenderness and press fluid values.

Distribution of subcutaneous fat was studied on beef carcasses that were graded Choice by a U.S.D.A. grader. Twenty-three points were measured on each carcass. The thickest fat deposition was found over the rump area. Many significant correlations were found but no single point was found that gave a sufficiently accurate indication of thickness at a majority of the other points. Relationships tended to be higher between points that were near to each other.

- V. Summary of progress and conclusions to date:

A system of mild inbreeding accompanied by selection on the basis of performance has shown good promise for developing satisfactory beef cattle.

Crossline calves sired by Brae Arden and Havre Line II bulls and out of Utah Line I Herefords were heavier at weaning time than were

the straightline calves. The Brae Arden cross calves were heavier than the Havre II calves both years of the test.

VI. Application of findings:

A system of mild inbreeding accompanied by selection on basis of performance would appear to be suitable and promising for use in cattle herds. Some linecrosses give increased performance. It appears that some of the Hereford lines now available in the stations in W-1 have lines that can be strongly recommended for topcrossing and linecrossing in commercial herds.

This project has provided and demonstrated useful and practical methods of measuring performance for rate and efficiency of gain in cattle.

VII. Work planned for the future:

This project is being revised. In the revision it is planned to measure growth and efficiency in detail in cattle and determine causes of variation.

Performance of crossline and straightline cattle will be compared. The influence of genetic differences, degree of finish, conformation, and age upon carcass characteristics will be investigated.

VIII. Publications:

Bennett, James A. 1966. Meat for an expanding population. Utah Farm and Home Science 27(4):144-146.

Jensen, Ruth Ann B., Ethelwyn B. Wilcox, J. A. Bennett. 1967. Breeding and roasting temperature as related to beef tenderness and other quality factors. (Abstract) Utah Academy of Science.

Mikesell, Keith. 1967. Subcutaneous fat distribution on beef carcasses. M. S. Thesis. Utah State University. Logan.

IX. Project summary:

Utah Agricultural Experiment Station

Cattle Inventory - June 1967				Total
Breed	Panguitch Hereford	Logan Hereford	Logan Shorthorn	
Line	I	II		
Purebred or grade	Purebred	Purebred	Purebred	
Bulls (12 mo. or over)	12	3	1	16
Cows (2 yr. or over)	54	16	19	89
Heifers (yearlings)	10	5	5	20
Calves - Bulls	30	8	8	46
- Heifers	20	7	10	37

Cow Production Data - 1967 calves				
Number cows bred to calve:				
As 2-yr.-olds	4	4	3	11
At 3 yr. and up	15 ^a	49	21	85
Number calves born from:				
2-yr.-olds - Alive	4	2	3	9
- Dead	0	2	0	2
3-yr.-olds and up - Alive	13	48	19	80
- Dead	0	1	2	3
Number calves weaned	12	45	21	78
Percent calf crop ^b - Born	100.0	100.0	100.0	100.0
- Weaned	70.5	84.9	87.5	83.0

^aTwo pregnant cows culled. Percent calf crop calculated on remaining cows

^bCalves born or weaned/cows bred

Prewaning Performance - 1966 calves				
Birth weight	82.0	63.5	64.0	67.2
Weaning age	206	207	216	209
Adjusted weaning weight ^c	421.2	407.0	417.0	412.2
Weaning score:				
Conformation	2.0	2.1	2.0	2.1
Condition	2.8	2.9	2.7	2.8
Inbreeding	6.6		11.9	

^cAdjusted to mature dam, 205 days of age

Utah Agricultural Experiment Station

Postweaning Performance - 1966 calves			
Breed	Hereford	Hereford	Shorthorn
Line	I	II	
Sex	Males	Males	Males
Method of feeding	Individual	Individual	Individual
Number on test	18	2	5
Initial weight	493	608	576
Initial score:			
Conformation	2.0	1.7	1.9
Condition	2.8	2.3	2.5
Final weight	806	922	880
Final score:			
Conformation	1.8	1.7	1.9
Condition	2.5	2.3	2.5
Average daily gain	2.57	2.34	2.46
Feed efficiency	21.02	16.46	17.00

WASHINGTON STATE UNIVERSITY

I. Station: Washington Agricultural Experiment Station

II. Project title: Comparison of breeding systems for improvement of beef cattle

III. Personnel:

Experiment Station:

C. C. O'Mary, Project Leader, D. D. Bennett

U. S. Department of Agriculture, Agricultural Research Service,
Fort Collins, Colorado

Bradford W. Knapp, Acting Investigations Leader

IV. Nature and extent of work done this year:

Routine data were collected to fulfill the objectives of the project. The new test barn was completed and put into use in October 1966. Semen from three Angus herd sires was sent to Hawaii to continue the cooperative project with that station. Meat and blood samples were sent to Colorado to continue the cooperative project with them. No other work was done on the project, as the leader was on sabbatical leave.

V. Summary of progress and conclusions to date:

None

VI. Application of findings:

None

VII. Work planned for the future:

Routine procedures will be continued on those projects already started. New projects and other work will be contingent upon the return of the project leader.

VIII. Publications:

None

IX. Project summary:

Washington Agricultural Experiment Station

Cattle Inventory - June 1967				Total
Breed	Angus	Angus	Angus	
Line	A	B	C	
Purebred or grade	Purebred	Purebred	Purebred	
Bulls (12 mo. or over)	5	7	8	20
Cows (2 yr. or over)	24	20	23	67
Heifers (yearlings)	7	7	7	21
Calves - Bulls	8	7	12	27
- Heifers	11	11	6	28

Cow Production Data - 1966 calf crop

Number cows bred to calve:					
As 2-yr.-olds				13	13
At 3 yr. and up	23	21	26		70
Number calves born from:					
2-yr.-olds - Alive				12	12
- Dead				1	1
3-yr.-olds and up - Alive	21	19	22		62
- Dead	2	1	3		6
Number calves weaned	17	18	19	12	66
Percent calf crop ^a - Born	91.3	90.5	84.6	92.3	89.2
- Weaned	89.5 ^b	90.0 ^c	82.6 ^d	92.3	88.0

^aPercent calf crop born = number calves born alive/number cows bred

Percent weaned = number calves weaned/number cows bred, excluding cows sold with calves at side

^bFour cows sold with calves at side^cOne cow sold with calf at side^dThree cows sold with calves at side

Prewaning Performance - 1966 calf crop

Birth weight - Bulls	71	68	65	64	67.5
- Heifers	65	63	64	60	63.5
Weaning age - Bulls	200	219	206	143	190.6
- Heifers	205	201	196	133	193.2
Weaning weight - Bulls	518	500	431	328	450
- Heifers	440	413	398	295	401
Adjusted weaning ^e - Bulls	488	430	399	452	450
weight - Heifers	424	398	382	436	401
Weaning score:					
Conformation - Bulls	14	14	13	14	14
- Heifers	14	12	13	14	13

^eAdjusted for age of calf (180 days) and age of dam (15-10-0+5)

Washington Agricultural Experiment Station

Postweaning Performance - 1966 calf crop					Total
Breed	Angus	Angus	Angus	Angus	
Line	A	B	C	Yearling	
Sex	Bulls	Bulls	Bulls	Bulls	
Method of feeding	Individual				
Number on test	6	7	13	4	30
Average age on test	262.5	254.3	245.2	182.0	242.3
Initial weight	616	527	599	402	559
Days on test	150	150	150	150	150
Average daily gain	2.07	2.05	2.52	2.40	2.30
Feed efficiency:					
Lb. feed/100 lb. gain	817	781	756	630	757
Final weight	912	835	977	762	902
Final score:					
Conformation	14	1	14	13	1

Postweaning Performance - 1966 calf crop					
Breed	Angus	Angus	Angus	Angus	
Line	A	B	C	Yearling	
Sex	Heifer	Heifer	Heifer	Heifer	
Method of feeding	Individual				
Number on test	9	11	5	2	27
Average age on test	247.0	240.7	258.6	178.2	241.5
Initial weight	495	463	510	331	473
Days on test	150	150	150	150	150
Average daily gain	1.67	1.57	1.92	1.68	1.68
Feed efficiency:					
Lb. feed/100 lb. gain	770	766	748	595	751
Final weight	755	704	817	551	730
Final score:					
Conformation	14	13	14	13	14

UNIVERSITY OF WYOMING

- I. Station: Wyoming Agricultural Experiment Station, Laramie and Gillette Substation, Gillette
- II. Project title: Criteria for improving effectiveness of selection in beef cattle
- III. Personnel:

Experiment Station:
G. E. Nelms, Project Leader, R.A. Field, and C. O. Schoonover, Animal Science Division; Leon Paules, Substation Division; Brinton Swift, Veterinary Science Division; W. W. Ellis, Biochemistry Division

U. S. Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado
Bradford W. Knapp, Acting Investigations Leader
- IV. Nature and extent of work done this year:

Data from the first calf crop, dropped in 1966, under the recent project revision is in process of collection and evaluation. Preweaning and postweaning performance is shown in the project summary. Not enough data are yet available to indicate progress in the separate lines with respect to effects of selection on growth and carcass traits.

The Wyoming station continued its cooperation in the Regional Genetic-Environmental Interaction project by supplying another sire from the Gillette line. The previously enrolled cooperator herd was withdrawn from participation.

Weaning data from the 1966 calf crop of the cooperator herd are summarized as follows:

<u>Sire</u>	<u>Sex</u>	<u>Number</u>	<u>Weaning age</u>	<u>Weaning weight</u>	<u>190-day weight</u>
4	M	17	188	289	290
	F	6	198	286	283
311	M	10	184	278	279
	F	4	185	268	270
307	M	4	204	279	274
	F	11	194	273	271
71	M	11	186	297	298
	F	5	191	251	251
33	M	7	192	296	295
	F	5	183	261	264
0006	M	6	190	282	282
	F	10	192	292	291
- All -	M	55	189	288	288
	F	41	191	275	274

Weaning data from the cooperator herd were obtained at two separate weigh dates (11-2-66 and 12-5-66) late in the season and weaning weights appear abnormally low.

A study of selection intensity and phenotypic response in the closed Gillette line of Herefords over a 12-year period was completed. It was found that an average selection intensity of 24.1 kg. per generation in yearling weight resulted in a 10.9 kg. phenotypic increase. Inbreeding of calf was found to have a detrimental effect on 180-day weight (-.465 kg. for each 1 percent increase in inbreeding), while other traits measured were not significantly affected. Inbreeding of dam had no detectable effect on any of the observed traits.

Two methods of measurement for Longissimus dorsi in beef cattle were evaluated and compared. Plastic grid readings were found both more rapid and more repeatable than tracings on matte finish acetate sheets measured with a compensating polar planimeter. Tracings did have the advantage of providing permanent drawings of the l. dorsi area.

V. Summary of progress and conclusions to date:

Data collection has proceeded according to plans, but not enough data have been accumulated for proper evaluation of revised selection procedures and mating systems. The selected sire from the 1965 calf crop for use in the carcass line had the following relationship with the mean of the selected group in carcass traits: cold carcass weight +90 pounds, total retail cuts +60 pounds, rib-eye area +2.5 square inches, percent retail cuts -.8%, and Warner-Bratzler Shear value +1.3. Carcass grade of High Good was equal to the mean of the group.

The Angus line sire selected from the 1965 calf crop had the following relationship with the mean of the selected group in carcass traits: cold carcass weight +45 pounds, total retail cuts +46 pounds, rib-eye area +1.2 square inches, percent retail cuts +1.7%, Warner-Bratzler Shear value +2.8, and carcass grade was High Good compared with the group average of Low Choice.

VI. Application of findings:

Indications are that, under proper management and control, it is possible to make progress through selection even in small closed populations of beef cattle.

Through the use of the plastic grid technique a rapid, repeatable measurement of l. dorsi area is obtainable without the use of complicated or expensive equipment.

VII. Work planned for the future:

Data collection in growth and carcass traits under revised systems of selection will be continued. Effects of increased inbreeding in the Gillette line will continue to be studied.

VIII. Publications:

- Nelms, G. E. and P. O. Stratton. 1967. Selection practiced and phenotypic change in a closed line of beef cattle. J. Anim. Sci. 26:274-277.
- Riley, M. L., R. A. Field and G. E. Nelms. 1966. Comparison of two methods of measuring the area of the Longissimus dorsi muscle. Amer. Soc. Anim. Sci. West. Sect. Proc. 17:145-148.
- Riley, M. L., G. E. Nelms, C. O. Schoonover and L. R. Landers. 1967. Factors affecting carcass traits of inbred Herefords. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:57-62.
- Riley, M. L. and C. O. Schoonover. 1967. Carcass weight adjustments for carcass traits. Amer. Soc. Anim. Sci. West. Sect. Proc. 18:51-56.

IX. Project summary:

Wyoming Agricultural Experiment Station

Cattle Inventory - June 1967					Total
Breed	Hereford	Hereford	Hereford	Angus	
Line	Gillette	Laramie	Laramie	Laramie	
	Growth		Carcass		
Purebred or grade	Purebred	Purebred	Purebred	Purebred	
Bulls (12 mo. or over)	4	3	4	6	17
Cows (2 yr. or over)	30	41	31	38	140
Heifers (yearlings)	9	6	3	8	26
Calves - Bulls	16	21	13	16	66
- Heifers	13	16	15	18	62

Cow Production Data - 1966 calf crop					
Number cows bred to calve:					
As 2-yr.-olds	8	5	6	8	27
At 3 yr. and up	31	28	20	34	113
Number of calves born from:					
2-yr.-olds - Alive	6	4	4	7	21
3-yr.-olds and up - Alive	25	19	16	29	89
- Dead	2	2	0	0	4
Number calves weaned	30	20	20	35	105
Percent calf crop ^a - Born	85.6	75.8	76.9	85.7	81.4
- Weaned	76.9	60.6	76.9	83.3	75.0

^aNumber calves born or weaned/number cows exposed

Prewaning Performance - 1966 calf crop				
Birth weight - Bulls	79	78	80	69
- Heifers	72	70	76	64
Weaning age - Bulls	187	201	193	191
- Heifers	189	183	189	184
Weaning weight - Bulls	374	449	417	418
- Heifers	354	353	368	375
Adjusted weaning - Bulls	362	411	393	398
weight ^b - Heifers	341	348	354	368

^bAdjusted for age only

Wyoming Agricultural Experiment Station

Postweaning Performance - 1966 calf crop						
Breed	Hereford		Hereford		Hereford	
Line	Gillette		Laramie Growth		Laramie Carcass	
Sex	Male	Female	Male	Female	Male	Female
Method of feeding	Group - Feedlot					
Number on test	8	21	7	8	7	3
Average age on test	199	201	211	187	203	203
Initial weight	380	364	471	341	454	388
Days on test	168	168	168	168	168	168
Averagedaily gain	2.67	1.55	2.38	1.24	2.40	1.46
Final weight	829	625	870	548	858	633
Average inbreeding	16.1	17.1				

Postweaning Performance - 1966 calf crop				
Breed	Angus		Crossbred	
Line	Laramie		Laramie	
Sex	Male	Female	Male	Female
Method of feeding	Group - Feedlot			
Number on test	6	8	20	15
Average age on test	206	201	197	189
Initial weight	432	400	439	397
Days on test	168	168	168	168
Average daily gain	2.42	1.51	2.45	1.59
Final weight	838	653	851	664

PROJECT REPORTS AND DISCUSSIONS

PROJECT REPORTS AND DISCUSSION

Arizona

Dr. Roubicek:

Since this is a cooperative project in the true sense of the word, we must talk this over some time during the meeting. There are some decisions that must be made and must be made by the committee members collectively.

We finally have a program that seems to be operating properly. We have been able to complete a number of the analyses on some of the hepatic and blood constituents that we have been taking for several years. The last of the analyses will be completed shortly.

On the top cross data it was a matter of testing top cross heifers in a systematic plan over a four-year period. This analysis is virtually completed.

The main portion of the report is concerned with the cooperative bulls obtained from your stations and used at San Carlos. We have completed the first feeding trial of the progeny of these bulls. I think everyone associated with these animals was extremely well pleased with what he saw.

We ran into at least two problems we can avoid from now on. When the first group of bulls came in from the stations we got them very late and they came in in poor shape. We had trouble getting the job done. Since then, the bulls have come in early and we have had better success. The first year we had some late calves.

The other problem was one we did not suspect. When we moved the cattle from San Carlos to Tucson we had a grub problem. Our cattle have all been treated with systemics and we will not have that problem again.

We averaged three pounds a day on these animals, and this was not a hot ration. This one year is not a real sample but we do have something we were looking for. We do have a difference in performance between lines. I think there is no question but that we are going to have a divergence among lines. The overall acceptability of these bulls is excellent.

The choosing of these test bulls was as nearly random as possible. It was done by number--this bull will go to Tucson, the other will go to the range. By actually pulling out about six, we had a set of bulls good enough to move into the nonregistered herd by the Indians.

The performance of these animals is difficult to compare with what we might expect from other sources. However, just a little distance from where these test facilities are located there is another set of pens for the Beef Cattle Improvement Association. It is managed as

other stations are. While the W-1 bulls were on feed test, bulls at this Beef Cattle Improvement station were also on feed test. They were fed with exactly the same ration, by the same feeders, at the same time, but they were bulls from registered herds selected to go on feed trial. Our bulls out-performed the selected bulls from these herds by about half a pound per day. Almost 9 pounds of feed per pound of gain for those, and ours about 7-1/2 pounds.

One other point, and I have to have your decision--just what do we do now?

The next bulls are theoretically the last bulls. We have three more feeding seasons to go through, then these are the last bulls.

1. We can stop
2. We can continue to test these lines if you think these data we have are not adequate
3. We could test heifers instead of bulls
4. We might be able to test both bulls and heifers on feed

I would like to say this, that some of us feel very strongly that perhaps the cow productivity from the heifers bred in this particular study may be more important than what we are pulling out in feedlot tests. So, we would like to obtain performance--fertility and performance--records on all of the heifers produced in this particular project. Our Veterinary Department has indicated willingness to work with us on fertility problems. Again, we would have a chance to make a sort of line evaluation on the basis of cow performance to tell more about these lines. But not in just a year. This will require more time. We do honestly want to get all the data we can to help evaluate these lines.

Obviously, we do have to make a decision as to just where we go after this breeding season. I can assure you the cow herd will be available, our abilities and facilities. We will do everything we can to get the data you would like to have on these lines of bulls.

Dr. Holland:

Can you explain the big difference between Arizona and New Mexico bulls in performance?

Dr. Roubicek:

One bull we had to pull out because he was not settling the cows. These two bulls you are talking about-- Our cow allotment when we allot cows to these particular bulls, this is done by random--list the cows in order starting with the oldest cows and taking a number out of the hat from 1 to 10 and assign the cows to a pasture. Then take the bull number out of a hat and assign him to a pasture. New Mexico had a

greater proportion of first-calf heifers than the other sire group. But I think the thing that happened was, your bull, one from Nevada, and the Royal bull were extremely late in starting breeding. This can be avoided by getting the bulls in earlier. Your bull came in awfully late. So we had young calves.

Dr. Holland:

I would appreciate it if in the future you would give age and other such information.

Dr. Roubicek:

We should get these bulls in time to collect semen, then get them well acclimated to go to the herd--to be turned in in May. We make at least two collections on these bulls.

Dr. Bogart:

Do you feel that you have sufficient data with the four years to make the test what it ought to be, or do you feel you should continue?

Dr. Roubicek:

We have limited data of value on this first year. We rushed things a little with administrative complications and so on, so we are not sure just what the unbiased value of this information is. We always take a chance of a bull going out with a very short calf crop. I would think the four years should be adequate.

California

Dr. Rollins:

The California study of heterotic effects in crossing of Angus, Hereford, and Shorthorn breeds is proceeding according to plan. One thing which is new involves the use of the cattle in this project over and above the original objectives of the project. It is work we started last summer in developing a meat index for beef cattle. The meat index work grew out of our work with the double muscled cattle.

I circulated during the year a proposed new project dealing with double muscled cattle. Those of you who responded, responded favorably on this project.

We started working on this and in contrasting the double muscled animals to normal animals they have a very rounded rump. Also, there are very deep creases or grooves between certain muscles. We decided to develop a method for judging the crease between certain specific muscles. We took a group of normal cattle and graded them in the usual way. Then we looked at them from this point of view and discovered that there is a variation in the rump size in these groups. So we routinely judged

these cattle by what we call a rump gage and then we judged the crease--the crease between the semimembranosus and the semitendinosus.

The bulls were fed out to Low Choice.

We later analyzed the data and came out with a correlation of 0.8 with the amount of nonfat in the carcass in percent of slaughter weight.

I recognize that this is a small amount of data on which the correlations are based, but I wanted to get the material out. The original report was based on data from 25 animals. This year we will process 200 animals on which we will get carcass data and if this sets up as we think it does from this limited sample we will have something of interest to the beef industry.

How to use the rump gage (page 12): These are taken from photographs of live animals. Number 4 is the improved beef type--straight top line. As you go toward number 1, this is the typical double muscled animal. But move the gage back and forth and you can get in on the back. Then get the top line to fit as well as you can. Normal animals will fall in a range mainly from 3 to 4, but may get down to 2.5. This is affected somewhat by condition and age. After we get the rump shape we score it. The creases are judged by the visibility of the creases. We are working with three different creases. Score them numerically--most visible, 4; slighter, 3, 2, and 1.

We put these into a linear function and that is where we came up with a correlation of 0.8 for the bulls and 0.7 for the steers.

This year we will have a lot more to add and will put it into a machine and see what we come out with. If it really has the predictive value that is indicated, then my idea is to judge young breeding animals with it. Performance test in a deal like Carl is running--put the animals on a feed test to get growth, work out differences in milking ability of the dams, then put the meat index on them.

Dr. Bennett:

How much is involved in using the rump gage and judging the creases?

Dr. Rollins:

Judging the visibility of the creases is a question of how much you think it is worth to you. If you want to get a look at the creases the animal has to have very little hair, so you have to clip the rear end of the animal. I am working on the idea of developing a portable chute and getting the animal in there. If the accuracy of the index is high enough, a person will be willing to use it.

You can use this in two ways. If you are working with known animals I think you use it for a meat index. If you want to see the double muscle characteristic, it identifies that.

Colorado:

Dr. Brinks:

Actually, my report could be passed over until next year. We have been recently completing analyses, although those mentioned in the report were completed within the past year or eighteen months.

Briefly, we have completed the three-year study where we milked the first-cross heifers and also individually fed these calves from them.

Also completed were bull and heifer carcass studies. These are not too different from other data.

We are getting facilities for a twin study at Fort Collins. We will get going on that and try to apply genetic parameters.

This is a short report, but we will make a complete report next year.

Dr. Cramer:

This work is being done on a three-year cooperating contract grant with ARS to study genetic aspects of serum lipids and intramuscular and adipose lipids. There are a couple of points of interest in the report mailed out.

We are analyzing the lipids by stations and the only one we have complete is the Miles City 1965 collection (35 animals). The phospholipids in the blood run about 28 percent stearic acid and about 27 percent oleic acid. Phospholipids from intramuscular lipids are only about 17 percent stearic acid and oleic acid is 33 percent. What the reason for this is I do not know, but this carries through in some of the other fractions, too.

Another thing is the triglyceride fatty acids in blood serum. We have never seen anything like this 12 percent linoleic acid (18:2) in muscle fats or adipose fats of any kind. They are usually about 2 to 4 percent.

Another important difference is in the 18:1 and 18:2 content of cholesterol esters in blood serum and intramuscular lipids. Blood serum esters are 6 percent lower in 18:1 and 17 percent higher in 18:2 than intramuscular cholesterol esters.

Maybe we can do something with blood serums.

Differences between sires within lines--we got many sire differences. No significant differences between sires in blood serum total lipids. Another thing we observed, the bulk of the sire differences in the blood serum fatty acids were in the 16 carbon acids and longer,

whereas in intramuscular fats the bulk of the differences were in the shorter chain acids.

The subcutaneous fats are done. The total fatty acids are about done. Now we have to go back and separate the serum and intramuscular fats into different fractions and get these done. If the laboratory technician can run eight samples (and that pushes her) then we would have 394 continuous days of operation.

Dr. Blackwell:

Is there any overall measure of the significance in the different lengths of fatty acid chains?

Dr. Cramer:

Yes. The iodine numbers--any significant differences we do get on these will be meaningful. We have pretty well given up running iodine numbers. I calculated theoretical iodine numbers and there is just no relationship between the theoretical and actual iodine numbers. So I decided that actually running iodine numbers doesn't mean much.

The iodine numbers reported were the calculated iodine numbers from the actual fatty acid composition, so that differences between lines of sires I do think would be very meaningful.

Hawaii

Dr. Cobb:

I will give some information on the part relating to the Arizona-Hawaii project. The first year we had so few numbers that I would conclude that the first year's data did not give us much information. From the second year we do have enough numbers to have some information. We will wean the second calf crop in August.

At one ranch we will have 3 to 12 calves from one bull as a result of some bulls having 25 percent and some 75 percent calf crop, so we do have a great variation. The Royal line is low. We seem to have some trouble getting calves out of the Royal line.

This year we were able to inseminate about 30 cows per bull, so we can look forward to having sufficient numbers of calves per line.

At one ranch, of 54 calves we have 64 percent males. This is probably due to small numbers. Another year we had a worse distribution but in the reverse direction.

We ran into some computer problems--programming, primarily. But we did get data on the feeding out of the animals for five years. I think there is some indication of significant interactions in some cases.

We did a little more analysis of fatty acid composition as relating to some of the taste panel trials of animals and we got some indication there that gives some idea that there is some relationship between fatty acid composition and flavor.

With regard to the crossbreeding work, this is just getting started.

We are very much in favor of getting additional semen from Arizona, as before. From our point of view, I think it would be fine to get one or two more years of information.

Idaho

Dr. Christian:

I think the main thing I want to discuss--you recall that last year we had a discussion of the effects of inbreeding on fertility. Following this discussion, I have been doing some preliminary investigating in an attempt to be better able to describe fertility in cattle. To do this I have adapted in various ways the geometric distribution in an attempt to explain what happens in fertility. It is simply one of the various probability distributions.

Essentially, the first success will occur in the $k^{\text{th}} + 1$ trial.

$$P(X = k + 1) = pq^k$$

$$\mu = 1/p$$

$$\text{Var.} = q/p^2$$

The waiting time to the first success is exactly the same regardless of the failures to the first success.

I went back to the literature and took the data presented by Barrett in 1948, which is the best set I know of for they are data in which there was actual pregnancy diagnosis. In this set of reports, pregnancy occurred at first, second, etc., service. Four services approximate the length of breeding season we find in beef cattle (90 days plus or minus). We started with 100 cows and took the percentage of cows pregnant for this particular service. How closely would the geometric distribution approximate the data I prepared? Assuming what I found at first service for this model, the actual number of cows pregnant from each of the four services, I think, is a fairly close approximation.

In addition, let's assume that approximately 4 percent of the net population is permanently sterile but that the percentage conception is approximately the same for all of the other cattle. I took 0.544 of the net to get 0.567 conception rate.

This summer I came back to the literature and pulled out additional reports of fertility, primarily in dairy cattle. I have attempted to

		Hilder et al. 1944 J.D.S. 27:981	Gowen and Dove 1931 Me. A.E.S. B. 360:170	Gowen 1918 Me. A.E.S. B. 274:205	
Total cows - 5 or more services		3557	7679	1801	
Total cows - 4 services		2996	7402	1789	
Actual services per conception:					
5 or more S/C (a)		2.63	1.63	1.32	
4 S/C (b)		1.74	1.48	1.28	
Percent of cows conceiving at service number	1	Actual (P_1)	44.9	65.3	78.4
		Theor. 1 S/C (a) (P_2)	38.0	61.3	75.8
		Theor. 1 S/C (b) (P_3)	55.9	67.6	78.1
		Theor. from S/C (b)-equation (P_4)	43.0	63.0	77.0
		Theor. 4 percent sterile (P_5)	44.9	65.3	78.4
	2(pq)	Actual	19.4	19.5	15.4
		Theoretical from P_1	24.7	22.7	16.9
		Theoretical from P_2	23.6	23.7	18.3
		Theoretical from P_3	24.7	21.9	17.1
		Theoretical from P_4	24.5	23.3	15.4
		Theoretical from P_5	23.9	20.9	14.4
	3(pq ²)	Actual	12.8	8.5	4.6
		Theoretical from P_1	13.6	7.9	3.7
		Theoretical from P_2	14.6	9.1	4.4
		Theoretical from P_3	15.9	7.1	3.7
		Theoretical from P_4	14.0	8.6	4.1
		Theoretical from P_5	12.7	6.7	2.6
	4(pq ³)	Actual	7.1	3.1	1.0
		Theoretical from P_1	7.5	2.7	0.8
		Theoretical from P_2	9.1	3.6	1.1
		Theoretical from P_3	4.8	2.3	0.8
		Theoretical from P_4	8.0	3.2	0.9
		Theoretical from P_5	6.8	2.1	0.5
	5 or more	Actual	10.6	3.6	0.7
		4 percent sterile	11.7	5.0	4.1

Knapp and Hayden 1934 Ohio A.E.S. Bimon.B.166	Trimberger and Davis 1945 J.D.S. 28:554	Erb et al. 1944 J.D.S. 23:549	Seath and Staples 1941 J.D.S 24:510	Eckles 1929 Minn.A.E.S. B. 258	Total	Average
719	1341	922	934	1720	18673	
690	1253	916	900	1564	17510	
1.71	1.70	1.56	1.70	2.15		1.85
1.51	1.53	1.38	1.49	1.72		1.56
62.2	60.2	72.1	65.7	46.6		62.7
58.5	58.8	64.1	58.8	46.5		54.1
66.2	64.4	72.5	67.1	58.1		64.1
61.0	59.5	70.5	62.0	37.0		56.8
62.2	60.2	72.1	65.7	46.6		62.7
22.6	18.6	18.7	18.2	20.8		19.3
23.5	24.0	20.1	22.5	24.9		23.4
24.3	24.2	23.0	24.2	24.9		24.8
22.4	22.6	19.9	22.1	24.3		23.0
23.8	24.1	29.7	23.6	23.3		24.5
21.9	22.4	17.9	20.7	24.0		21.7
8.8	7.7	6.3	8.4	11.4		9.7
8.9	9.5	5.6	7.7	13.3		8.7
10.1	10.0	8.3	9.9	13.3		11.4
13.4	7.8	5.5	7.3	10.2		8.3
9.3	4.8	6.1	9.0	14.7		10.6
7.7	8.4	4.5	6.6	12.3		7.6
3.5	5.7	2.3	4.1	6.0		5.0
3.4	3.8	1.6	2.7	7.1		3.3
4.2	4.1	3.0	4.1	7.1		5.2
2.6	2.7	1.5	2.4	4.3		3.0
3.6	4.0	1.8	3.4	7.3		4.6
2.7	3.1	0.0	2.1	6.3		2.6
4.7	3.9	0.7	3.6	11.9		7.8
5.5	5.9	0.4	4.9	10.8		5.4

do the same thing with these reports.

Actual is also geometric--actual, theoretical from P_1 , theoretical from P_2 in which we calculated the probable conceptions from the actual number of services. This actual service per conception may be a little misleading because of culling from seventh service on. This also is not a very accurate estimate of services per conception, for we have truncated it.

One of the problems which has bothered me in measuring fertility--and others raise various questions to my explanations--I visualize when we are actually measuring fertility every time we breed a cow we are conducting a progeny test. The resulting fertilized egg really is a progeny. We can measure this particular trait (the livability) only by living or dead. So, we have the case of a progeny test in which the number of observations we get on a particular individual is affected by the individual's phenotype. On the cows most fertile we get only one observation, the less fertile we get two observations, the least fertile we get four observations and we throw the individual out.

So it is not surprising to me that when we measure the heritability we end up with a very low heritability. We should be able to measure some other way than an all or none trait.

Montana

Dr. Blackwell:

Our program of data analysis has not been very great. A year ago Don Anderson completed a Master's thesis and reported the essential things he found. It is now being put into manuscript form.

We have moved the Hereford line from Bozeman to Havre and this year they were put in a five-line reciprocal cross study. The Angus line has been closed. It will not be inbred strongly, but we are using the bulls within the line now.

A project cooperative with ARS on milk protein analysis on cattle at Miles City is in its second year. More milk samples will be collected next week. We have 250 from crossbred and straightbred cows and from linecross and straightline cows.

Mr. Flower has developed a project using Japanese quail in which he is evaluating inbreeding-outbreeding and I think this will be productive in evaluating mating systems. He is using as a selection index weight of egg production over body weight equals efficiency of production.

We moved 40 yearling heifers from Havre to the Red Bluff Ranch last fall and will use them to get information on mothering. This spring we moved heifers down to Bozeman and will get information on them on calf production.

We are in the same situation as many other universities, changing over from the 1620 to another computer, so that means stop and wait.

We have a new building going up at the main station so will have better facilities for handling cattle.

Mr. Dynes, the meats man, is taking a year's leave. He will, hopefully, analyze all of the meats data collected at the Havre station over the years.

Last year we had access to the cow herd at the State Prison. Next year we hope to supply semen to the Prison, five Hereford lines, for matings. I think we will have 500 cows, perhaps more.

One thing I would like to mention here to get something before the group. This central testing station is a matter we need to be concerned about--to promote or not promote. We need to find out just the role in beef cattle improvement. We have two in the state of Montana inter-related with the Montana Beef Performance Association. They are asking some questions I feel inadequate to answer at times. The whole matter of testing stations should be discussed in the not too distant future.

Dr. Brinks:

Is there any specific reason why you discontinued the selection study?

Dr. Blackwell:

That program has been going twenty years. We felt that we should evaluate where we are. I wanted to get the Bozeman Hereford line involved. In the new proposal we won't completely abandon this, but it won't take all of the facilities at Havre as it has in the past.

One reason why I feel we should take a look is that the recurrent aspect of this program hasn't been given very much hope for success. The selection of sires based on their offspring was based on growth rate in the feedlot primarily, which is a highly heritable trait and is not one we would expect industry to use. I think we are making a different version of this and I want to discuss it when we discuss the project. It has merit as a system that needs to be evaluated, but I think we should evaluate it just a little differently.

U. S. Range Livestock Experiment Station

Dr. Pahnish:

First, the crossbreeding study. The data on Phase 1 of the crossbreeding study to evaluate effect of heterosis in the cross has been completed and that material is now in manuscript form. Table 1, page 2, gives some idea of how the breeds function as sire and dam. With Herefords we obtained heavier birth weights with Hereford as breed of

dam rather than breed of sire. Charolais, heavier birth weights with Charolais as sire, but the other three with Charolais as dams. The other values were nonsignificant except Angus steers a little bit higher weaning scores with Angus as breed of sire.

Page 3, table 2, cross advantage or estimates of heterosis in various traits from crossing Hereford, Angus, and Charolais breeds. In most cases in steer progeny heterosis is in the nature of 3.5 and 4 percent except in weaning score, where it is lower. Heterotic effect was lower all the way through for heifers than it was for steers, by about half. In that table those cases in which the averages for the crossbreds exceeded the midparent averages are indicated. There were some significant differences between the reciprocal crosses, and those were confined to Hereford-Charolais and Angus-Charolais crosses. Charolais bulls on Hereford cows exceeded in birth weight, and Hereford bulls on Charolais cows gave higher birth to weaning gains. Charolais bulls on Angus cows gave somewhat heavier birth weights, with Angus on Charolais higher rate of gain birth to weaning, higher weaning weight, higher weaning score. Angus on Charolais showed the most promise, in that growth birth to weaning and weaning weight very closely approached the growthiness of the Charolais breed that went into the cross and also exceeded the weaning grade of the Angus--growth being the strong point of the Charolais, score being the strong point of the Angus.

The Brown Swiss crosses were carried somewhat as a sideline to this study. The Brown Swiss breeding was introduced by using Hereford, Angus, and Charolais bulls on Brown Swiss cows. These crosses cannot be compared in all respects with the other crosses. The calves were about 15 percent heavier, weighed 80 to 90 pounds, weighed 50 to 55 pounds more at weaning due to higher level of milk production of the Brown Swiss dams. Scores at weaning tended to be somewhat lower than for the beef breeds, but all finished well within the Choice grade.

The steers--two-breed crosses--were fed to a weight range of 1000 to 1050 pounds and then slaughtered. The average time on test for straightbreds was 261 days to reach that range; for crossbreds, 250 days, or 11 days less; for the Brown Swiss cross, 238 days, or 23 days less than the straightbreds.

Rate of gain in the feedlot, the crossbreds gained about 0.1 of a pound per day more than the straightbreds of beef breeds. Brown Swiss crosses gained essentially the same as the other crosses. Carcass grades--not much difference in crossbreds or beef breeds and straightbreds, all straightbreds being somewhat higher.

Phase 2 of the crossbreeding study evaluates maternal qualities of crossbred females. We have two years' data. From two crops of calves there appears to be no particular advantage for crossbreds against straightbreds except 4 to 8 percent in favor of crossbreds in productivity.

Phase 3--hybrid vigor from two- and three-way crosses. This has not come far enough to say much about it yet. As it stands at the

present time based on one crop of calves, the three-breed crosses show some advantage over two-breed crosses and straightbreds in weaning weight and weaning score.

Development of superior lines--we are making one comparison at the present time evaluating genetic progress to get the progress made in Line 1, started in 1934, and in Line 10, started somewhat later. Line 1 semen collected in 1956 from two bulls dropped one in 1953 and one in 1955, another bull dropped in 1961 and one in 1963 (some of the semen stored ten years is doing just as well as the more recent semen) was used on grade Hereford cows. There appears to be some advantage from the later bulls all the way through. The same thing has been repeated the second year. Those calves are now on the ground and the cows are being inseminated from Line 10 bulls.

There is nothing on the carcass study at present.

The crossline study conducted by Mr. Urick is conducted in three phases that correspond primarily to the procedures used in the crossbreeding study. He has given information on heterosis in postweaning traits. One thing, it appears that the great advantage for the crosslines is during the adjustment period immediately following weaning and during the first period or two on test. The heterosis appears to be higher at that time than later on in the feeding period. It seems to decrease progressively during the feeding period. And the same is true of the heifers that are carried on the range and supplemental feed during winter.

Phase 2 of the crossline study evaluates maternal qualities of crossline dams. We have data on two calf crops. Progeny of crossline heifers have been 22 pounds heavier than progeny from straightbred heifers. There seems to be the same advantage that shows up in the crossbreeding study.

Phase 3 is just getting started. There is nothing to report there.

Genetic-environmental interaction--there is no particular change in the picture at Miles City. The only comparison so far is the cattle of Line 1 origin with cattle from Florida at Miles City. Miles City cattle have been growthier all the way through. They withstand winter conditions somewhat better--require somewhat less handling (there has been only one particularly severe winter).

Comparing Miles City with Brooksville at Miles City, the Line 1 cattle are growthier cattle; at Brooksville it is the other way around. But actually measuring genetic-environmental interactions, the project has not progressed far enough at the present time to say much about that.

The Miles City station is still sending bulls to Arizona, has supplied meat samples to the Colorado station, and milk samples to the Montana station which they are going to use in a study of protein fractions. There is also a possibility of using some of the data from the

carcass line for a graduate problem, providing the data lend themselves to the project that the Colorado station has in mind.

Dr. Rollins:

In the table on page 6, the percent heterosis reaching the maximum around 6 to 7 months of age, then going down, this is similar to what we found in the inbreeding studies with Jersey. It seems that the inbreeding depression was greatest 8 to 9 months--in a sense, the inbreds were catching up. It may be similar to what you are getting.

Dr. Brinks:

Heterosis is higher during stress periods. Actually, from weaning time until they went on feed the inbreds lost weight where the crossbreds gained weight, but for the first 28 days the crossbreds outgained the inbreds. The inbreds were outgaining at the end.

Nevada

Dr. Bailey:

Here in Nevada we have continued with the five lines at the two locations, which we have discussed in the report. These were continued as two-sire lines for all five lines. Again, as in the previous ten years, we tested all progeny of both sexes.

Another thing that was done this year was to analyze the first ten years of performance test data. We considered this a progress report. Five years ago we went through this material and got some adjustment factors from it. This time we tried to get a rough idea of the real effectiveness of selection for specific characters. When you consider that we have come through only two generations and have just got rid of some of the foundation dams, we have too short a period, although it seems long chronologically.

In going to the summary of the first ten years' data, it appeared that we should at this time analyze data separately by sexes for each location, for when we look at averages or means, consistency trends, etc., it looks as though we would not be justified in pooling sexes.

Average weaning weight, age, and conformation we adjusted for age of dam. Daily TDN was not adjusted for anything--crude value for total feed consumption. Efficiency (not awfully efficient) Kg. gain/100 kg. TDN adjusted for net weight to try to compensate for the differences in feed requirements.

In table 1 we have shown means for inbreeding. The level of inbreeding is pretty much the same at both locations. There are sizable location differences and some sex differences at the two locations and differences in characteristics for location and sex.

Conformation values as we have used them here are pretty much the same at the two locations (the California system with higher value

indicating superior conformation--maximum value 100, cull 67).

In table 2 an attempt has been made to summarize briefly values from this study, reporting primary characteristics. Negative trends in efficiency and in gain have surprised us, for in some of these lines efficiency and gain were used as the primary character on which selection was based. Effects of inbreeding are negative, so with gradual increase in inbreeding we did expect some depression in traits, especially growth traits. The adjustment factors did not change the real order of these lines.

We think the main reason for this negative trend in efficiency is environmental fluctuation. According to our plan, pretest environmental effects are in here. An animal so much larger in terms of absolute gain is going to make a bigger gain. The largest portion of the ration is hay. If we get great fluctuation in the quality of the hay this is going to cause fluctuation in gain. If we used a complete mixture we could cut down on this some, but thus far this has not been possible. Our guess is that we have these fluctuations and we cut this off in a trough so the trend is negative. We seem to get some sex response in these trends. The bulls don't seem to do what we expect them to do. But we are finding that the bulls are becoming more and more efficient.

There is some indication that the heifers are more stable and possibly a better indicator of what is happening when calculating real trends in gain and efficiency from studying these trends. There is no clear-cut divergence in these lines after ten years' study.

Steve Hammack has been working on a study in changes in body composition which may result from selection.

We have been trying to feed all genetic groups the same ration and trying to make comparisons within the same line instead of with others. Half of the bulls have been slaughtered which were on test. The remainder are being fed out to 1000 pounds and estimates of body composition are being made with the specific gravity technique to get an idea of whether there are gross differences among the lines in body composition and growth traits.

In comparing gain of bulls during the fattening period (after performance test), there is very little difference among these lines in daily gain during the fattening period. We can make a general statement that gains of bulls at Knoll Creek compared with bulls at the main station; the Knoll Creek bulls seem to be gaining more rapidly but that may be compensatory growth because the Knoll Creek bulls are in poor condition.

Another point of comparison--carcass fat in the three lines at Reno, the early slaughtered group, the bulls in the conformation line were fatter, the carcass was fatter, than bulls selected for gain and efficiency. Selecting for conformation, we may be selecting for fatter animals.

The third set of sires was sent to Arizona. Another set will be sent this year.

The pilot study for beef cattle selection experiment--the rat study--a couple of these traits are shown in the figures in the report. Analysis of the rat data will be the next project.

It seems without question that there are large differences between diets and growth rate, so we are evidently getting a situation where there are different levels of nutrition available to these animals. There may be some question in the genetic-environmental interaction studies as to whether we have distinctly different environments.

There is some indication of compensatory growth. The post-test gain (70 to 100 days) on rats which received regular diet ad libitum there is indication of some relationship between gain from the post-weaning period and the period following 70 days to 100 days. There evidently is some relationship. We are anxious to look into the genetic association for the growth rate between these two periods.

The second and final phase of the rat study is about complete. Random progeny were chosen and sacrificed at the beginning of the test period--28 days of age. Littermates of these rats were fed out in pairs (by two's in individual cages) and sacrificed at the end of the test period, 70 days of age. It is not completed and not much information is yet available. Selection on regular diet for growth rate seemed to be better than selection for growth rate on limited diet.

There are 30 to 40 cows in each line. The plan is to continue for a period. We hope to be able to make statistical and chemical analyses on these animals. We will send more animals to Arizona. We will complete chemical analyses and feed consumption on the rats. We will begin analysis of the data.

New Mexico

Dr. Holland:

We will get the last data on our heart condition study this fall when our calves are born. I believe we will have enough matings to determine whether these defects are simply inherited.

We are reducing the size of the herd at Las Cruces because we are having pressure on us for land. The Old Line is being reduced; the out-cross line may be discontinued. I hope to hold onto the Old Line until we can get tests in Arizona and other places so we can evaluate this line.

We will replace our W-1 project with a crossbreeding project.

We have a volume of data from three Masters' theses. One is a study of fertility in cattle. These data have been analyzed with

chi square.

I am hopeful that next year we will have a lot of discussion of analysis of data following the analysis for the regional bulletin.

Another thing that has been of concern is hydrocephalus. I think it would be very productive if in the future we would discuss genetic trash and get some idea of what is happening in industry and pose the question, should hydrocephalus and other trash be as prevalent as we think it is, should we alert breed associations.

Oregon

Dr. Bogart:

In our diallel crossing of three inbred lines we have essentially completed the first phase of the study in that we have collected data on all of the bulls carried to 1000 pounds weight. The data include birth weight, suckling gains, gains 450 to 800 pounds, feed efficiency 450 to 800 pounds, gains and efficiency 800 to 1000 pounds, endocrine weights, and carcass evaluation including organoleptic tests.

The heifers in this study are all being bred to the same Angus bull. We have one more breeding season for testing these heifers, so the data will be completed in 1969. We will have the calf-producing ability of these cows for two calf crops.

Our diallel crosses have not been analyzed, but there seems to be more heterosis in the females than in the males, and there is more variability in the females. We seem to be picking up more heterosis for postweaning than preweaning gains. The reason may be that our environment is putting a lid on the preweaning period and, therefore, heterosis can not express itself very effectively. The pasture is good until June 10. From then on it is not good. We do see heterosis in the early part of the suckling period.

Nicotinamide nucleotide coenzymes in liver tissue were studied. We find a very close association that if we have high coenzymes (concerned with fat production) associated with this is a high fat percentage in the carcass, lower lean percent, smaller thyroid gland, lower gains during the feed test period. The inbreds are low. It appears there is heterosis for increased lean, greater gains, larger thyroids. Negative heterosis for coenzymes and percent fat in the carcass.

I would like to take liver biopsies and see what is happening during the development of the calf at all 100-pound increments. Also, I would like to see what might be done with the cattle if we pay attention to the coenzyme level. We might be able to use this as a predictor rather than progeny testing, etc.

We have done some basic studies with house flies. We have analyzed the data for heritability, genetic, environmental, and

phenotypic correlations and standard deviations for four traits-- pupa weight, adult weight, egg production, and emergence time. We are ready now to start the selection experiment.

In the mouse study we are using radiation stress for selecting for litter size and 28-day weight. These lines are replicated, and at the fifth generation every animal was sterile. We are now studying endocrine glands and doing cytogenetic studies to see why. I would have expected a gradual depression.

We have been using mice to compare elite with index selection. Elite, one fourth high in one trait, one fourth high in another. The index, put all four traits in the index and select that way. Four generations. I can not yet say which is going to be the more effective.

Utah

Dr. Bennett:

At our station we have been working on developing two Hereford lines and one Shorthorn line. For two years we involved the Hereford lines in crosses. We are now using them as straight lines.

We are in the process of revising the project. We have a great deal of data but we are having a change of computers so there is a question of programming.

This year we conducted some cooking tests on carcass production in the lines and were able to have three sire groups represented. We did find sire differences in flavor and overall acceptability as rated by a test panel, but not for tenderness. Our work on actual press fluid in comparison with the taste panel has a very poor relationship. Some of the samples the panel rated high were very poor on press fluid. High juiciness by a taste panel seems to be something different from juiciness by press. On tenderness we are very well up in the acceptable area. Tenderness is not a real problem in the cattle we are working with.

A study was made of beef carcasses in the Choice grade to see how fat is distributed. There is the most fat from the top of the rump area. The brisket area is second. No single or no two or three points seem to be adequate for describing distribution of overall fat. This raised the question of just how fat is laid down. Do animals actually start at midpoint and lay it out?

We have some other developments. We have finished the meats laboratory and hope to have a meats man within a year. The laboratory is in operation.

I should like to get your advice as to just what we should do with the Shorthorn line. Inbreeding is about 12 percent average--some higher. The performance is still acceptable, but there is very little interest in our state in Shorthorns. What use do they have in this

region, or in some other area? In our proposed project we want to have Charolais in the study, and we can have no Charolais until we remove the Shorthorns.

Dr. Brinks:

I would hate to see the Shorthorn line lost, for they are one of the few lines of Shorthorns with desirable carcass and all desirable characteristics.

Dr. Cunidff:

How many do you have?

Dr. Bennett:

Thirty animals. They are good cattle. These Shorthorns compare very favorably with the Herefords, and our Herefords are at least average. They average 12 percent inbreeding, but they are very variable. The line has been closed since 1950. We have had a number of cows that stayed in the herd for quite a long period. That is why the inbreeding is so variable.

Washington

Dr. Hillers:

Dr. O'Mary has been on sabbatical. All that has been accomplished is routine collection of data. No data analyses or data interpretations have been made.

Wyoming

Dr. Stratton:

Dr. Nelms has been on sabbatical leave this past year in Canada. He returned the day after I left for the American Society of Animal Science meetings.

We had Bob Taylor come up from Arizona. He continued to collect data on the project, which was revised two years ago.

The Shorthorn herd was sold. We purchased 40 head of Hereford heifers and are starting a new project for carcass merit and growth studies.

In cooperation with Arizona we collected data on a Wyoming herd the first year but lost our cooperator the second year. We are hopeful of having a man adjacent to Laramie as a cooperator and we might be able to get back on this next spring.

Two papers were presented at the Western Section. One is on

carcass weight adjustment for carcass traits from data we have collected over a number of years. The second study is factors affecting carcass traits of inbred Herefords, and the data came out of the Gillette herd.

Having been away for seven years, it is a pleasure to get back here and visit with you. One thing that impresses me is the increased cooperative work the region is doing. The Arizona work, the Colorado station fat determination work, Montana milk work.

E F F I C I E N C Y O F F E E D U T I L I Z A T I O N

a n d

I M P R O V E M E N T I N B E E F P R O D U C T I O N

E F F I C I E N C Y T H R O U G H

S E L E C T I O N F O R B O D Y C O M P O S I T I O N

EFFICIENCY OF FEED UTILIZATION

Dr. Meyer:

The problem in talking about feed efficiency is you are talking about a topic which is like motherhood and God. You just have to be in favor of efficiency.

Both speakers this afternoon say, also, when you talk about weight gain people often become emotional, and usually when they lose their emotions about size and become interested in experimenting with animal science they become involved with feed efficiency and weight gains.

If we go back to why we have animal husbandry departments and what the mission of these departments should be it might be of some help in how one approaches and designs experiments. An animal husbandry department is to study the biology of animals to enhance world food supply in the most efficient manner. In the first place, we work on biology. We are biologists. We have a group of disciplines within a multi-disciplinary department, the animal husbandry department. We have to keep in mind that we apply this discipline of biology; we are applied scientists. By applying any science we also apply management. So, are we working on the biology phenomenon, or are we going to try to work the two together and call it feed efficiency?

Dr. Meyer's address is covered in the paper:

Meyer, J. H. and W. N. Garrett. 1967. Efficiency of feed utilization. J. Animal Sci. 26(3):638-646.

Dr. Ward:

It is a pleasure to be here.

I have not had much experience measuring weight gains in animals and when I started doing a review of the literature and looking into the subject I came to the conclusion that feed efficiency as it is expressed is not very valuable. I was happy to find support for this conclusion in the recent paper by Meyer and Garrett. I guess Jim Meyer, being a dean, can go further than I can. I was ready to eliminate feed efficiency, but he says go ahead and eliminate weight gains, also.

My area of interest is body composition. I got into this subject of feed efficiency through discussion with Jim Brinks and Brad Knapp. You can blame them for getting me on this program.

The W-1 group is to be congratulated for working with the nutritionists. Unfortunately, you may not get too much help. It seems the work here raises several problems.

Feed efficiency has been used so long, and is it so nice sounding, but it doesn't seem useful for what we have in mind.

If one is interested in selecting animals for higher protein, there is the interaction of age and size of the animal. If you want animals at 1100 pounds with little fat, go to a large animal. Obtaining animals with less fat does not necessarily require genetic selection. Fat represents the excess of feed the animal obtains above requirements for bone and muscle. As for interest in lean body mass, the composition of lean body mass of mature animals is rather constant. Ash content increases slightly but is rather insignificant in older animals. Fat is something that is added on top of lean body mass. How to determine lean body mass is difficult.

IMPROVEMENT IN BEEF PRODUCTION EFFICIENCY THROUGH SELECTION FOR BODY COMPOSITION

Gerald M. Ward

The purpose of this meeting is to discuss improvements in the efficiency of beef production by genetic means. The questions are simple and basic to the whole livestock industry, but simple and basic questions have a way of being elusive. As I see the questions they are: 1. What measurements can be made which evaluate the efficiency of breeding animals or their offspring, and 2. How should experiments be designed to obtain this information with a degree of precision adequate for making judgments on breeding stock? Animal breeders have, I think, every reason to expect that feed efficiency data are the answer to this problem, since they have been so widely used by nutritionists. The term itself, feed efficiency, has a ring of being both practical and scientific. In fact, it is neither. Meyer and Garrett (1967) have pointed out its shortcomings and the reasons therefor. I can

only reiterate their conclusion, that it is unsatisfactory for scientific work. It really describes nothing in a quantative sense.

Efficiency of calorie deposition: The prospects of selecting beef cattle for improved physiological efficiency, I believe, are dim, although this apparently can be done in mice and rats. The difficulties with cattle are two-fold, one methodological and the other physiological. First is the cost of obtaining the data. Meyer and Garrett (1967) have outlined the data necessary for a thorough evaluation of caloric efficiency. The cost to obtain data on a population of cattle would appear to be prohibitive. Simplifications, however, have been proposed for sheep (Reid 1963). The second and more important deterrent from selecting animals for improved efficiency is the real possibility that the variability in this character is so low that genetic selection is not practical. Efficiencies for tissue deposition of energy in terms of conversion of metabolizable energy ingested above maintenance are available for cattle and sheep under a number of conditions. Blaxter (1962) reported for fattening sheep fed grass a mean value of 47 ± 4.6 percent. For dairy and beef cattle fed a variety of diets, Reid (1962) found a mean of 58.4 ± 3.5 percent, and Flatt et al. (1965) reported for dry dairy cows fed all forage a value of 50.2 ± 3.6 percent. The data in table 1 indicate that not only is the variability in efficiency small but that it is essentially the same for cattle and for sheep. The small coefficients of variation associated with these efficiencies can be interpreted to mean little opportunity for genetic selection for increased efficiency in the conversion of ME to body tissue. Reid (1962) has concluded that the variation in the efficiency with which cows utilize ME for milk production is so small that genetic selection for this trait would be impractical. Whether the same is true for growth and fattening apparently has not been determined. The suggestion is sometimes presented that there may be genetic differences between animals in maintenance energy requirements. Two possibilities are suggested: 1. That the actual requirement per unit of metabolic size is different, and 2. that there are differences between animals in the efficiency of feed energy utilization for maintenance. I am not aware of work to support either idea. Table 1 certainly does not, although the number of animals is very limited.

Table 1. Differences in Energy Utilization by Ruminants

	Efficiency of ME for maintenance or above maintenance energy for fattening	
	3 steers 450 kg.	3 sheep 50 kg.
Maintenance	80.4 ± 2.6	80.4 ± 8.6
Production	51.4 ± 2.6	53.5 ± 1.4

Included two diets and five levels of intake
Blaxter and Wainman. 1961. J. Agric. Sci. 57:419.

Selection for traits which increase economic efficiency: Selection for improved physiological efficiency may not prove feasible, but other factors besides physiological efficiency which contribute to

economic efficiency may be amenable to improvement through selection. Hunger or feed intake per unit weight or ($W^{3/4}$) appears to be variable with some indication of fairly high heritability (Mather 1967). The feed intake of beef cattle is relatively low as compared to dairy cattle and probably can be increased. Stomach capacity is not the factor limiting feed intake when either type of cattle is fed concentrated rations.

The importance of high feed intake is that energy requirements are generally the same regardless of feed intake, and increased energy intake means a higher percentage of energy available for gain in body substance or greater daily gains. Higher daily gains mean a shorter period to reach a constant weight and fewer days for which the overhead cost of maintenance must be paid. However, there is usually a small but significant decrease in the efficiency of feed digestion as intake increases. The decrease is largely associated with greater energy losses in the feces and although significant is not of the magnitude of the improved efficiency due to reducing the overhead (daily maintenance requirement).

Short term trials to determine the consumption rate of standard diets could be the basis of considerable improvement in the cost of beef production. Crampton and his associates have published extensively on a voluntary feed consumption method to evaluate forages. I am not aware of trials of this sort with cattle on high concentrate rations. The data can be obtained from the feed efficiency data where cattle were fed ad libitum.

Economic efficiency can be increased by reducing the amount of fat on the carcass. The energy content of one gram of beef protein is 1.2 Kcal while one gram of beef fat contains 7.5. In other words, five times as much energy is required for fat deposition as for protein. Any substantial reduction in carcass fat will automatically improve the efficiency of producing beef. It is simple enough to reduce the fat content of the carcass, but the goal is obviously not a fat-free carcass. We need a standard or goal for selection which will be acceptable in the market.

One frequently hears the suggestion that a change be made from selection for energy efficiency to selection for efficiency of protein deposition. However, protein content is largely a function of the physiological age of the animal and rate of energy consumption. Rate of protein deposition in the carcass can not be separated from energy intake.

A third suggestion of selection for economic efficiency rests on the possibility that there may be genetic differences between animals in the partitioning of energy between protein (or muscle) and adipose tissue. The idea is interesting but the biochemical evidence is meager.

Growth rate and body composition: All of these suggestions for improved efficiency of meat production rest upon selection for changes

in body composition, which in relatively young feeder cattle are to a great extent determined by their growth patterns.

Many formulae have been proposed to describe the complexities of growth, but Brody considers the two equations below to be as good as any and far simpler than most. The growth curve for young animals can be represented as:

$$W = Ae^{kt}$$

which is the formula for a first order chemical reaction.

W = weight at any time

A = "original" weight

t = time in months

k = constant

For slower growth after puberty, the equation is:

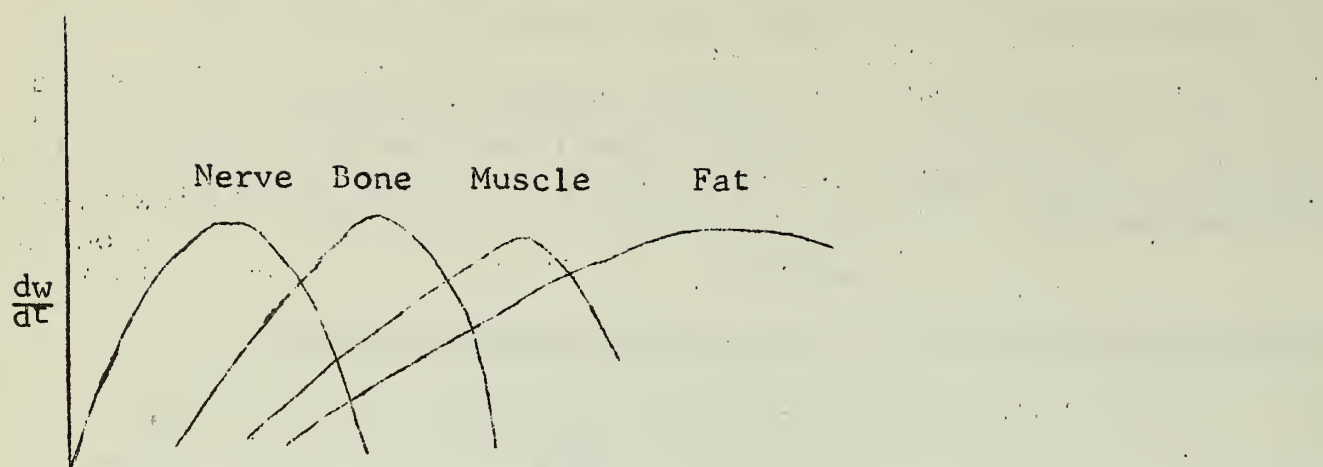
$$W = A - Be^{-kt}$$

where A-B = growth to be made to reach mature weight. This says that the "maximum" size is being reached at a decreasing rate. This equation requires a value for maximum size, which is a difficult assignment.

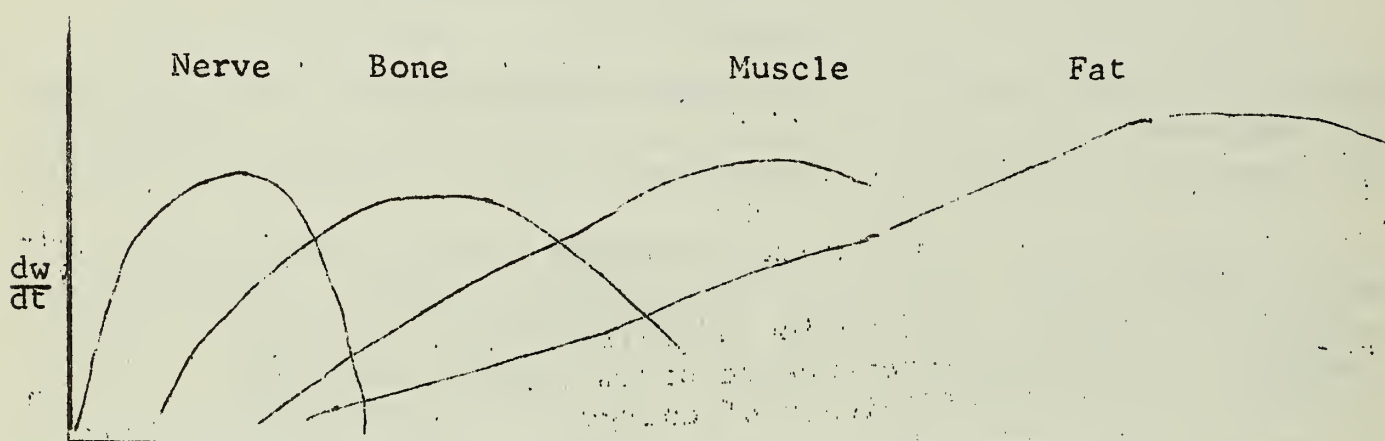
The factor k is a function of energy intake or more precisely energy intake minus maintenance requirement. As this increment is increased the economic efficiency of energy deposition tends to improve because t is reduced as k increases if W remains the same. A, t, and W can all be changed at will by the feeder, while possibly k can be controlled by the geneticist. For example, A (mature weight) is greater for Holstein and Charolais than for Hereford and Angus.

There are three major categories of growth: bone and minerals, muscles or protein, and fat. Water is associated with the first two but not with the third. The rate of growth of each is largely independent and they proceed at different rates as illustrated in figure 1. The stimulus for bone growth is by far the greatest and will proceed even though the animal is on a submaintenance ration. Muscle growth will proceed largely as a function of the energy available above that required for maintenance, bone growth, and muscle development. Guenther et al. (1965) have described growth characteristics as related to level of feed intake.

The maximum lean body size in an animal is genetically determined but the rate at which this size is approached is determined by the energy intake of the animal (in this discussion it is assumed that nutrients such as proteins, vitamins, minerals, are supplied in adequate quantities). The fact that bone, muscle, and fat each has its own rate of development means that in order to get significant fattening in earlier periods the energy intake must be reasonably high; otherwise, through a considerable part of the development period the animal will be producing largely bone and muscle and only minor amounts of fat. The data in table 2 illustrate this point for sheep and table 3 for cattle.



Early Maturing - Beef Breeds



Late Maturing - Dairy Breeds, Draught Breeds

Figure 1. Rate of development of bone, muscle, and fat

Table 2. Four Groups of Lamb Carcasses and Their Efficiencies

	I	II	III	IV	
Body composition:					
Fat, %	23.4	26.1	17.2	17.2	
Ash, %	3.41	3.35	3.73	3.83	NS
Energy, kcal./kg.	2984	3190	2475	2460	S
Milk GE to lamb energy gain, %					
	42.3	45.3	37.5	37.3	S
Efficiency of milk protein conversion to body protein, %					
	37.3	35.8	37.4	40.5	NS
Estimated maintenance energy, megcal.					
	61.9	62.6	111.7	114.8	

I, II Single; III, IV Twins. I and III about 95% NRC energy requirement, II and IV about 110% NRC energy requirement

Garner, Hogue and Bensadoun. 1964. J. Animal Sci. 23:943.

Table 3. Carcass Data from Five Breeds of Cattle

	Days on gain	ADG	Dress- ing %	Slaughter Weight	Age	Feed cwt./ gain	Separable Bone	Fat	% kidney fat	% GI tract
Hereford	310	1.84	62.2	835	455	869	14.1	31.3	3.9	15.5
Angus	315	1.76	63.4	811	474	909	12.8	34.3	4.8	15.8
Brahman	362	1.50	62.4	790	531	936	15.3	24.4	3.5	14.2
Holstein	294	2.16	59.7	846	444	776	17.6	22.1	4.3	18.2
Jersey	378	1.56	57.5	742	527	959	16.2	26.2	6.1	21.3

On feed 3 to 8 months--average, 5 months. Slaughtered at 900 pounds or 20 months of age, whichever came first.

Cole et al. 1963, 1964, and 1965. J. Animal Sci. 22:702, 23:71, 24:120.

In order to improve feed efficiency or economic efficiency, it is necessary to look for a system which involves not only a reduction in fat content of carcass but also includes reducing the time which the animal is fed in order to reduce the caloric cost of maintenance. One method would be to slaughter animals at a younger age and start heavy feeding at younger ages. This means that equivalent amounts of energy for the lifetime would be supplied to the animal in a shorter period of time. If such a management system were to be used, selection pressure might be toward marbling in younger animals if this characteristic is an important factor in meat quality (Blumer 1966). Efficiencies in broiler production are achieved by killing birds of large potential size at a period in their development when they are growing rapidly and efficiently. However, this analogy should not be stretched too far, because, unlike the chicks, the cost for beef production in terms of support of the dam is a high percentage of the cost of production. Perhaps the most economic solution is to produce the absolute maximum in edible meat per animal because the cost of obtaining the calf is so high.

Another approach to the problem of reducing the amount of fat on the carcass is to utilize cattle with a greater maximum body size or lean body size and slaughter them at weights of 1000 to 1100 pounds. With animals of larger potential body size, a larger percentage of calories for a longer period of time will be converted to muscle as opposed to fat and thus at any weight will have a carcass with less fat. Selection for animals of greater potential body size, presumably if one were to select for maximum protein production this is the type of animal which would be obtained. Selection of large animals, however, does have the disadvantage that it would be necessary to maintain cows of larger size, which means an increased maintenance cost. A convenient solution to this problem would be to select small cows which produce larger calves or at least large steers.

Techniques for the determination of the body composition of live animals are badly needed for such work. However, it seems fair to say that methods still are not available. Precision, repeatability, and calibration are still troublesome problems for those techniques which can estimate body composition rapidly, cheaply, and conveniently.

Conclusions

1. Feed efficiency as commonly defined has no merit for livestock selection except as it incidentally evaluates hunger.
2. The variability in efficiency of energy conversion to body tissue should be evaluated from a literature search; likewise, differences in maintenance energy requirements.
3. There probably is little variability in these parameters.
4. Voluntary feed consumption varies with animals, is of great economic significance, and may be heritable.
5. Selection for increased carcass protein will increase economic efficiency and probably will result in selecting larger animals unless smaller carcasses become the fashion.
6. The possibility exists that there are heritable differences in the partitioning of energy between muscle and fat which are independent of body size. However, the evidence is lacking.
7. Satisfactory methods for determination of body composition of live animals on a large scale are not available at present.
8. Smaller brood cows that produce large calves would improve economic efficiency of beef production.

References

- Blaxter, K. L. 1962. The energy metabolism of ruminants. Hutchinson and Company, Ltd. London.
- Blumer, T. M. 1963. Relationship of marbling to the palatability of beef. J. Animal Sci. 22(3):771-780.
- Flatt, W. P., C. E. Coppock and L. A. Moore. 1965. Energy balance studies with dry, non-pregnant dairy cows consuming pelleted forages. In Energy Metabolism, Blaxter, K. L., Ed. Academic Press.
- Guenther, J. J., D. H. Bushman, L. S. Pope and R. D. Morrison. 1965. Growth and development of the major carcass tissues in beef calves from weaning to slaughter weight with reference to the effect of plane of nutrition. J. Animal Sci. 24:1184.
- Mather, Robert. 1967. Rutgers University. Personal communication.
- Meyer, J. H. and Garrett, W. M. 1967. Efficiency of feed utilization. J. Animal Sci. 26:638.

Reid, J. T., A. Bensadoun, O. L. Paladines and B. D. H. Van Nickerls.
1963. Body water estimations in relation to body composition
and indirect calorimetry in ruminants. Body Composition, Vol.
110. New York Academy of Science.

Reid, J. T. 1962. Energy value of feed--past, present and future.
Dedication symposium. Cornell University.

PROJECT REVISIONS

and

BUSINESS MEETING

PROJECT REVISIONS

Arizona

Dr. Roubicek suggested the extension of the present Arizona project for one year, because the data for the first year are slight. If the stations could provide bulls and if ARS would support the project for another year, five bulls from each line would be tested, giving more adequate information.

Dr. Holland:

I move that the Arizona station go on with the plans for another year, and ask Dr. Warwick to give favorable consideration to funding the research [1938-39 fiscal year].

Dr. Warwick:

Could I make a suggestion in addition to that motion--That a committee be appointed to give intensive study during the next year to the continuation of testing of the inbred line concept and make that a major item of discussion at the next W-1 meeting.

Dr. Holland included the suggestion in his motion.

Dr. Bogart seconded the amended motion. Motion carried.

Montana

Dr. Blackwell presented a preliminary revision of the Montana project and explained it in detail.

Title: Evaluation of breeding systems for beef cattle improvement.

Justification: Beef production is vitally important to the agricultural economy of Montana and to the entire country. Although regional characteristics of the industry exist, the beef cattle industry of the plains and mountains of the West and the cattle feeding industry of the mid-West must have certain goals in common. The production of feeder calves that are profitable to the range producer is essential in much of the Western Region. These same cattle must be able to go directly to the feedlot and make rapid and efficient gains and finally yield highly desirable carcasses. Examination of the effects of selection for growth at different stages of development on the various important traits of beef cattle is needed. More precise knowledge of the interrelationships among traits is required so that improved selection methods may be developed which will meet the multiple needs of the industry.

A careful evaluation of the progress made during the past 20 years in developing superior lines of beef cattle by selection and in evaluating a mating system, recurrent selection, is the first need of the Montana project. Although the period of time spent to date is relatively short in terms of cattle breeding research, the results of such an evaluation are timely and should provide important guidelines for planning future cattle breeding research.

Objectives: 1. To evaluate methods used in developing existing Hereford lines developed at the Montana Agricultural Experiment Station. 2. To compare different selection procedures for improving beef cattle.

Procedure: Objective 1. The four Hereford lines at the North Montana Branch Station and the one at Bozeman will be linecrossed reciprocally for two successive years (1967 and 1968). Two bulls and a minimum of forty cows per line will be used. All male offspring will be fed as steers and slaughtered. Weaning, feedlot, and carcass data will be obtained. All female calves will be maintained without selection to obtain records on their own growth performance as well as their calf producing ability. Three calf crops will be obtained on each group of heifers. The data will be analyzed to determine the magnitude of line difference and extent of line interaction. This will provide a test of the effectiveness of the recurrent selection program to date as well as the general merit of the lines of cattle that have been developed by the Montana project using record of performance procedures. Semen from all bulls used to accomplish objective 1 will be frozen, a portion of which will be used in the herd at the Montana State Prison to obtain an independent evaluation of the lines in topcross tests. If other cooperator herds can be obtained, additional test matings will be made. Birth, weanling, carcass, and calf production data will be obtained on the resulting progeny.

Objective 2. The three recurrent selection lines of cattle (lines 1, 2, and 3) at the North Montana Branch Station will be evaluated based on data obtained prior to the plan of work for objective 1. One of the three lines which exhibits the best combining ability with line 4 will be selected to continue this breeding system. This line will be divided into two sublines. Approximately 100 cows will be maintained in line 4 and 30 in each of the two sublines. Mass selection for weight per day of age as yearlings will be practiced in both lines. All straight line bull and heifer calves will be maintained without selection until yearling age. Approximately 50 cows in line 4 will be used for propagating the line and 50 will be devoted to progeny testing bulls from the recurrent line. All crossline progeny will be fed and slaughtered to obtain carcass data. Final selection of bulls to use in the recurrent line will be based on carcass merit of their progeny. Each line or subline will be propagated as a two-sire line.

The linecross females from objective 1 and those suitable cows and bulls available from the five original lines will provide the foundation for new lines. These cattle will be divided as equally as possible to form the following new lines:

1. Weaning weight: Mass selection accompanied by family selection will be directed toward improving weaning weights.
2. Postweaning growth rate in the feedlot. Mass selection accompanied by family selection will be directed toward increasing rate of feedlot gain.
3. Weight at about 12 months of age. Mass selection accompanied by family selection will be directed toward increasing weight at 12 months of age.

The calves in these three new lines will receive the same management, and performance records through 12 months of age will be obtained on all calves, both bulls and heifers. A relatively high plane of nutrition will be maintained in the feedlot. Each line will be maintained as a two-sire line with approximately fifty breeding females.

The Angus herd at Bozeman will be closed and two sublines of about 30 breeding females each will be established using two sires each year. In one group, selection will be based on weight of the calf at weaning per unit weight of the dam. Dam weights will be determined by the average of several weights taken during the year. In the other group, selection will be based on weight of the calves at weaning without regard to size of dam. Records on growth and other performance characteristics will be obtained on all offspring at 12 months of age.

At the initiation of objective 2, a frozen semen bank will be developed for use as a control on the progress of the selection experiments. In addition, repeat matings will be made to provide control on environmental trends. Continued use of cooperator herds for topcross testing via artificial insemination will be made to obtain comparative information on between-herd and sire effects and their interactions.

Records will be maintained to provide data for studying direct and correlated response to selection for economically important traits and certain components of these traits. This will include data on reproduction, birth, weaning, conformation scores, feedlot gain, carcass merit, and maternal ability of cows. Selection will be as clearly truncated as possible with limited attention to other selection criteria. Animals with serious abnormalities will be culled as judiciously as possible with due regard for the major selection criteria after thorough examination and study of the anomolous condition.

Probable duration: Objective 1 should be completed by 1973. Objective 2 will require at least 20 years, with evaluation at ten-year intervals.

Personnel: R. L. Blackwell, A. E. Flower, Claude Windecker, and F. S. Willson.

Institutional units involved: Department of Animal and Range Sciences, Montana Agricultural Experiment Station, Bozeman, and North Montana Branch Station, Havre.

Cooperation: The Agricultural Experiment Stations of Arizona, California, Colorado, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, and the Agricultural Research Service, U.S.D.A. cooperating under Western Regional Project W-1

Dr. Blackwell:

If the committee members will give this further thought and write me their suggestions and criticisms, that I shall appreciate.

Dr. Cobb:

Will the committee convey their ideas by mail to Dr. Blackwell at an early date relative to this project.

Utah

Dr. Bennett distributed a proposed project revision, which he discussed.

Title: Development of selection criteria for improvement of efficiency in growth and fattening in cattle.

Personnel: James A. Bennett, Project Leader, A. Jr. Nyman and Wm. Nay, Jr., assistants, and graduate assistants

Justification: The beef cattle industry is one of the major agricultural enterprises in the state of Utah and the income from sale of cattle is larger than the income from any other single agricultural source. Beef is a healthful and highly preferred food. The expanding population of the state, the nation, and the world will give a greatly increased demand for beef. Increased production and increased efficiency of production will be necessary to produce the beef to meet this demand. Knowledge of the components of variation in efficiency is basic to developing strains of cattle with the increased productive ability. Gross measures of efficiency have been made by numerous researchers. Now there is need for more detailed measures and increased knowledge of the physiological components and of the transmission of each.

Previous work and present outlook: The Utah station has been an active participant in the Western regional beef cattle breeding project (W-1) since its inception in 1947. Two lines of Herefords and one line of Shorthorns have been developed at the Utah station under a system of mild inbreeding. Postweaning feeding tests have been carried out throughout the study. Significant differences have been found (Bennett and Matthews, 1955) between sire groups for rate of gain, gross efficiency of feed utilization, and for final feedlot weight. Sex differences for these characteristics were pronounced.

The condition of the animal at the start and finish of the postweaning feedlot test appeared to influence the measure of efficiency.

Attempts were made to determine body composition in live cattle. Tritiated water was found to give good accuracy in this when proper techniques were used (Shumway et al., 1956). This method, however, is exacting and requires expensive equipment and, therefore, is not readily suitable to field application.

It has been recognized for many years that rate of gain is highly related to gross efficiency (Winters and McMahon, 1933; Black and Knapp, 1938; Roubicek et al., 1951). Body size has a pronounced effect upon efficiency of feed utilization. Klieber (1936) concluded that absolute rate of gain could be used as an index to efficiency only when animals are of the same size. Similarly, Knapp and Baker (1944) concluded that comparisons of gross efficiency should be made only between animals of the same size.

Lickley et al. (1960) reported a phenotypic correlation of $-.26$ between daily gain and feed per pound gain and when adjusted for regression on initial weight $-.45$. Genetic correlation between daily gain and feed per pound gain adjusted for initial weight was $-.59$.

Heritability estimates for efficiency of gain have not been as high as for rate of gain. Knapp and Nordskog (1946) gave a value of 48 percent, while Shelby et al. (1955) reported 22 percent and Lickley et al. (1960) gave 27 percent. Gregory et al. (1966) in comparing straightbreds and crossbreds found that heterotic effects on efficiency of feed use over a 252-day feeding period were small. They suggested, however, that heterotic effects may be larger if measured over a gain-constant basis through the same weight range.

Although heritability estimates for efficiency of gain are not high, they suggest that some improvement would result from selection. With refinements in measurement of efficiency and of the components of efficiency, increased rate of improvement should result.

It would seem obvious that differences in efficiency of feed use could arise from any of the following sources independently or in combination:

1. Differences in basal metabolism
2. Differences in ability to digest and assimilate feed
3. Differences in rate of gain with a resultant lower maintenance requirement to a weight-constant basis
4. Difference in energy value of tissue stored

Measurement of basal metabolism is difficult in beef cattle. No tests have been reported with the newer strains of cattle in the Western region.

Only limited reports are found concerning comparative digestibility in cattle. Baker et al. (1951) found that digestion of crude fiber was related to feed efficiency but digestion of other food nutrients did not appear to be significantly related to efficiency. Howes et al. (1963) concluded that, in general, Brahman heifers were more

efficient than Herefords in digesting all nutritional components except ether extract. French (1940) did not find significant differences in digestion coefficients for Zebu and Zebu-taurine crosses, although the digestion coefficients favored the Zebu. Phillips et al. (1960) reported an average dry matter digestibility of 67.7 percent for Zebu and 65 percent for Zebu crossbred steers. These results indicate possible differences in digestion powers associated with genetic origin and a possible relationship of digestibility and efficiency.

Differences in rate of gain have been observed by practically all investigators that have studied gains in cattle. The correlation between preweaning and postweaning rate of gain has been found to be low (Black and Knapp, 1936). Heritability values for postweaning rate of gain have been consistently reported to be high. Shelby et al. (1955) placed heritability for rate of gain at 60 percent, which is in rather close agreement with the 54 percent reported by Warwick et al. (1954). This is somewhat lower than earlier estimates of 97 percent by Knapp and Nordskog (1946) and 77 percent by Knapp and Clark (1950). These high values indicate that a real and continued improvement in gaining ability can be made by selecting on basis of postweaning rate of gain. The faster gaining animals would have an advantage in efficiency of feed use because fewer days would be required to reach slaughter weight. This would reduce the amount of feed needed for maintenance because total feed for maintenance is based upon body size and time. If time is reduced, the total feed for maintenance is reduced, thus giving greater efficiency.

The efficiency with which an animal puts on live-weight gains, as measured by feed units consumed per unit of gain, is materially affected by the composition of those gains. Brody (1945) points out that two steers may gain weight at different rates, yet gain energy at the same rate. This is possible because some types of gains involve greater energy storage for each unit of live weight gained. Brody (1945) and Maynard (1947) report that a pound of protein gained is necessarily associated with about three pounds of water, while a pound of true fat is not. Brody (1945) concluded that one gram of fat gain is calorically equivalent to about eight grams of protein gain when the associated water and the differences in energy values are considered.

Growth in animals is largely a result of increased storage of lean (protein) tissue and of bone tissue. As animals go through a fattening period, the proportion of fat increases and lean and bone decreases with a resultant drop in percentage of body water. Animals of different mature size and with different growth curves will differ in their ability to fatten at specific weights. Potential mature size and earliness of maturity will, therefore, influence gross efficiency.

Objectives: 1. Determine the importance of certain components that contribute to differences in efficiency of feed utilization during growth and fattening in cattle. 2. Develop selection criteria for improving efficiency of feed utilization in cattle.

Procedure: Objective 1. Determining importance of efficiency components.

The components to be given consideration will be:

1. Genetic differences
2. Differences in digestion ability
3. Differences in basal metabolism

Cattle of three genetic groups will be studied. These will consist of the inbred Utah Hereford line, straight Charolais, and Charolais-Hereford crossbreds. Feed requirements during the growth stages will be made commencing when calves are 60 to 90 days of age. Measurements will be continued on an individual feeding basis until market weight is reached. Weekly body weights will be taken and weekly feed consumption obtained.

Some animals will be slaughtered at a constant body weight of possibly 950 pounds while others will be carried to a condition-constant state, as accurately as can be determined, equal to that of the straight-line Herefords at 950 pounds live weight. Composition of the carcasses will be determined for fat in all cases, and for bone and lean on representative carcasses in each group. Representative animals from each group will be slaughtered and body composition determined at 205 days of age and 305 days of age as well as for the end points as described above.

Metabolism trials will be conducted on samples from each group on the growing and fattening ration and with mature animals in each group on an all-roughage ration.

Basal metabolism tests are difficult to conduct on cattle. Techniques will be investigated and attempts made to adapt techniques for conducting such trials on representatives of each group.

Objective 2. Develop selection criteria for improving efficiency

Properly arranging matings over several years' time will permit data to be collected that will be useful in developing selection methods for efficiency. It will be possible to obtain genetic and phenotypic correlations and heritability values for the various components. These may then be fitted into a selection index that will make selection more effective than any method now in use.

Date of initiation: 1947 Date of last revision: 1956
Date of completion: 1978

Institutional units involved: Animal Science Department

Cooperation: Animal Husbandry Research Division, Agricultural Research Service, United States Department of Agriculture in accordance with the memorandum of understanding pertaining to Western Beef Cattle Breeding Project and with the twelve Western States Agricultural Experiment Stations.

Literature Cited

- Baker, J. P., R. W. Colby and C. M. Lyman. 1951. The relationship of feed efficiency to digestion. *J. Animal Sci.* 10:726.
- Bennett, James A. and Doyle J. Matthews. 1955. Performance testing studies with beef cattle. *Utah Agr. Expt. Sta. Bul.* 377.
- Black, W. H. and Bradford Knapp, Jr. 1936. A method of measuring performance in beef cattle. *Amer. Soc. Anim. Prod. Proc.* 72.
- Black, W. H. and Bradford Knapp, Jr. 1938. A comparison of several methods of measuring performance in beef cattle. *Amer. Soc. Anim. Prod. Proc.* 103.
- Brody, Samuel. 1945. *Bioenergetics and Growth.* Reinhold Publishing Company, New Ycrk.
- French, M. H. 1940. The comparative digestive powers of Zebu and high-grade European cattle. *J. Agr. Sci.* 30:503.
- Gregory, K. E., L. A. Swiger, L. J. Sumption, R. M. Koch, J. E. Ingalls, W. W. Rowden and J. A. Rothisberger. 1966. Heterotic effects on growth rate and feed efficiency of beef steers. *J. Animal Sci.* 25:299.
- Howes, J. R., J. F. Hentges, Jr., and G. K. Davis. 1963. Comparative digestive powers of Hereford and Brahman cattle. *J. Animal Sci.* 22:22.
- Kleiber, M. 1936. Problems involved in breeding for efficiency of food utilization. *Amer. Soc. Anim. Prod. Proc.* 247.
- Knapp, Bradford, Jr. and A. L. Baker. 1944. Correlations between rate and efficiency of gain in steers. *J. Animal Sci.* 3:219.
- Knapp, Bradford, Jr. and R. T. Clark. 1950. Revised estimates of heritability of economic characteristics in beef cattle. *J. Animal Sci.* 9:582.
- Knapp, Bradford, Jr. and A. V. Nordskog. 1946. Heritability of growth and efficiency in beef cattle. *J. Animal Sci.* 5:62.
- Lickley, Charlene R., H. H. Stonaker, T. M. Sutherland and K. H. Riddle. 1960. Relationship between mature size, daily gain, and efficiency of feed utilization in beef cattle. *J. Animal Sci.* 19:957.
- Maynard, Leonard A. 1947. *Animal Nutrition* (2nd ed.) McGraw-Hill Book Company, New York.
- Phillips, G. D., R. E. Hungate, A. McGregor and D. P. Hungate. 1960. Experiments on rumen retention time, fermentation rate, and dry-matter digestibility in Zebu and European-type cattle on a grass hay ration. *J. Agr. Sci.* 54:417.

- Roubicek, C. B., N. W. Hilston and S. S. Wheeler. 1951. Progeny studies with Hereford and Shorthorn cattle. Wyo. Agr. Expt. Sta. Bul. 307.
- Shelby, C. E., R. T. Clark and R. R. Woodward. 1955. The heritability of some economic characteristics of beef cattle. J. Animal Sci. 14:372.
- Shumway, R. P., T. T. Trujillo, J. A. Bennett, D. J. Matthews and R. O. Asplund. 1956. Fat determinations in live steers using tritium injections. Amer. Soc. Anim. Prod. West. Sect. Proc. 7:XXIV-1-6.
- Warwick, B. L., T. C. Cartwright and M. V. Hazen. 1954. Beef cattle performance at Bluebonnet Farm. 1. Evaluation tests for gaining ability. Texas Agr. Expt. Sta. Bul. 790.
- Winters, L. M. and H. McMahon. 1933. Efficiency variations in steers. A proposed record of performance. Minn. Expt. Sta. Tech. Bul. 94.

Dr. Cobb:

Dr. Bennett would like to have each of you send him your comments by mail, with a copy to the regional office.

New Mexico

Dr. Holland:

We propose to crossbreed at two different locations in the state-- College Ranch and Fort Stanton.

♂♂	B	
	H	
	B	H
	♀	♀

The Brangus will be purchased and the Herefords produced in our own herd.

College Ranch is desert conditions. Fort Stanton is about 125 miles northeast of Las Cruces in mountainous country which has rainfall of 16 to 20 inches. Each location represents several million acres in the United States.

Herefords represent the major breed in the state. Brangus are coming into this country in great numbers. They range farther, get away from the water, actually lead the Hereford herd.

We would like to know how the straight Brangus are performing in the state as well as have information on the crosses. The Brangus may have advantages under desert conditions and not have advantage or it would be reduced at Fort Stanton. We have cattle born in the spring of 1966.

College Ranch

H	B
25	25

Fort Stanton

H	B
25	25

1967 - same as above

This will be the total number of animals the facilities can handle. The proposal will be to breed as three-year-olds.

1969 - each location

HxH	HxB	BxH	BxB
12	12	12	12

1970 - each group

24	24	24	24
----	----	----	----

1971

24	24	24	24
----	----	----	----

etc.

1973	12	12	12	12
------	----	----	----	----

Do we have enough animals?

I had though of throwing out the HxB and distributing those 12 animals in the other groups.

We would get the reproduction data, weaning weight and weaning grade, then postweaning we would steer all males and keep all females for further studies of the value of crossbred females. Both groups of steers would be brought to University Park.

Calves would be born in the spring, weaned in the fall, shipped in the adjustment period when moved to University Park. Fed to a constant weight. But should we include more weights? We will measure feed intake and gain. We would slaughter and get carcass information with specific gravity and by getting the trimmed retail high priced cuts.

Dr. Cobb:

Please send your suggestions to Dr. Holland, and let me remind you that the committee is to send comments to Montana and Utah also, with copies to the regional office.

REGIONAL BULLETIN

Dr. Brinks:

At the meeting last year we were instructed to appoint a committee to work on the first bulletin, preparing a rough draft. The committee appointed is Wade Rollins, Curt Bailey, and myself. We were also instructed to develop a questionnaire, which we did and which you now have filled out and returned. Those are the major accomplishments since last year.

I have been trying to break down the information on the questionnaire into tabular form which would be put in the Materials and Methods section;- a table on origin and history of these lines, also tables on number of lines, number of animals per line, inbreeding within the line, etc. We can do a pretty good job of writing up the Materials and Methods but we cannot finish that section until we get the inbreedings. We are still missing New Mexico, and a few lines at Miles City. Miles City Line 1 is a major job.

Mr. Knapp:

We have all of the fertility data but not all of the production data.

We are having a big problem with the inbreeding. Line 1 has more animals than the program and machine allow for, so it is a process of breaking the line down to smaller animal groups. The other lines that have not been done are based on Line 1--crosslines in which Line 1 was used.

We also have to put age of dam on all cards, since last year we discussed age of dam in the model. That includes all lines except, Reno. Age of dam was included in the original information.

Dr. Brinks:

Dr. Bailey will write the introduction. I will be responsible for the Materials and Methods section, and Dr. Rollins will prepare the literature review. We will get these portions combined and send copies to the committee members for review.

COMMENTS OF CHIEF, BEEF CATTLE BREEDING RESEARCH

Dr. Warwick:

The first thing I want to do is to apologize about the conflict on a date for this meeting. I presume I could have done something about it since I was on the committee that arranged the meeting which was in conflict. We do appreciate this group's agreeing to the present dates. We all realize that by the end of the week we are pretty well worn out by meetings.

From an administrative standpoint, you all know the most important thing happening to this project work was that Dr. Brinks changed positions during the winter. We are sorry to lose him from the ARS staff. We are glad, however, that he is staying with beef cattle breeding and will be connected with this project.

I appreciate the way Brad Knapp has filled in during the time this position has been vacant. We are trying to fill the position, but as yet have nothing to report.

Among others, the position was discussed with a man now working in Canada. He decided he would not be interested and one of the reasons given was that he wanted to work in an atmosphere that was free and unfettered. He wanted to work in an atmosphere conducive to free thought and action. In his opinion the atmosphere in Canada is better than in the United States. That is, of course, a matter of opinion. However, if there is an element of truth in it, I think we should take it seriously.

I believe most of you are familiar with the long-range study of agricultural research. This study was carried on by a joint committee of State Experiment Stations, the Cooperative State Research Service, and the Agricultural Research Service. It sets up a pattern that will influence our agricultural research in the future. It is probably the first time anything of this kind has been undertaken. If you have not already done so, I suggest you get a copy of this report from your Director and study it. (A National Program of Research for Agriculture-- Report of a Study Sponsored Jointly by: Association of State Universities and Land Grant Colleges and U. S. Department of Agriculture. October 1966.)

As a sequel to the long-range study, a number of commodity panels have been or will be appointed to follow up with specific recommendations on research. A beef panel is in the process of formation and will have the responsibility of making recommendations on problem areas in which it is felt research needs are greatest. Each panel is made up of representatives of State Experiment Stations and the U. S. Department of Agriculture. Doubtless the recommendations of these panels will have a great deal to do with future research.

Something has been said about performance testing. In the beginning, the various programs developed in different states along different patterns. At this stage the breed associations were indifferent. But recently breed associations have developed programs. They are giving them more emphasis and are pushing much harder than in the past. I am optimistic about performance testing programs, although the matter of procedures is causing some problems.

A committee with representation from W-1 met in 1958 in an effort to foster uniform procedures. Apparently the time was not ripe, since little came of the effort.

In 1963, Dr. Frank Baker, at that time U. S. Extension Animal Husbandman, organized a committee to study the matter. The committee met a number of times, and the outcome was the Beef Cattle Records Committee Report. Often called the Baker Report, it set forth the procedural ideas on which members of the committee could reach agreement. In my opinion it has been very useful. Many new and modified programs have used the report material as a basis for establishing procedures. Committee members did not feel the report represented the final word on the subject. Obviously, there are going to be changes with time.

In January of this year a meeting was called in Denver by Performance Registry International to discuss organization of a group to coordinate performance testing or perhaps to become an operating agency. Expressions at the meeting indicated that there is need for a coordinating body composed of breed organizations, state beef cattle improvement associations, Performance Registry International, and other interested groups. Dr. Baker was appointed chairman of an ad hoc committee to prepare a proposed constitution and bylaws for such an organization. Another meeting will be scheduled in September or October to consider organization. As was inevitable, there were differences of opinion as to the preferable nature of the new organization. Some wanted it to perform the same functions as DHIA does for the dairy industry. However, majority opinion favored a coordinating body with the functions of encouraging the use of performance testing and uniformity in procedures used. More than 50 organizations sent representatives to the Denver meeting. This indicates definite interest.

If, as seems likely, a new organization is formed, I hope research people will work closely with it. Performance testing procedures are bound to change with the passage of time. In looking back, DHIA has gone through many changes. Gradually, there has been a unification of ideas. As we gain experience with beef cattle it is my opinion there will be more uniform procedures. We are a bit inclined to dwell on minor differences rather than look at broad similarities. Why should we worry about 4 to 5 pounds variation in an adjustment factor? We should go along with the majority viewpoint in dealing with minor differences.

Regional project philosophy: Regional projects can be developed in three different ways. First, they may be merely a forum for discussion--people get together to discuss mutual problems and exchange ideas.

Second, there can be pooling of data for publications of more comprehensive and meaningful types than would otherwise be possible. This region has accomplished much along this line. But I believe in the long run justification for regional projects must be joint planning of projects.

Pooling of data implies this. Joint planning involves decisions on priorities and the best use of individual talents and available facilities. By and large, we have done too little of this. I am of the opinion that if we are going to be most productive we must do more of it.

I must admit some concern about the proliferation of crossbreeding projects in the past few years. I have strongly supported crossbreeding research for many years and had a part in initiating some projects a dozen or more years ago. The results have been quite favorable. I must admit I didn't anticipate as much hybrid vigor from crosses among the British breeds as we seem to be getting. It now appears that almost every state is developing a crossbreeding project. Are they all necessary? Are they designed to answer important questions not covered by existing projects?

Earlier in the meeting there was discussion on why individual stations develop specific projects. We must develop better mechanisms for determining broadly what research needs to be done and the place or places in the United States where each study can be done best for general applicability of results. Priorities must be developed for research, at least on the Federal side, and I think on the state side as well, and we are going to have to give more and more attention to doing the highest priority research. The Project Planning Budget System (PPBS) is forcing us in that direction. More and more decisions on research priorities are going to be Federal-State decisions. We must make every effort to concentrate on highest priority research having the greatest probability of paying off.

The closed-line concept has already been discussed. Where does it fit in the hierarchy of research priorities?

Did you all get copies of the report of the President's Panel on World Food Supply? The first volume came out in May, the second in June. If you haven't seen the reports, they are well worth your careful study.

Another report on applied research by a Presidential Committee is due out shortly.

(Dr. Meyer commented at this point that this committee was a panel put together to report on applied research. It is excellent. He also stated that program budgeting has some excellent points so long as it does not interfere with the freedom of the individual scientists as to where they should go. It forces them to do the significant experiment.)

Development is proceeding at the U. S. Meat Animal Research Center, Clay Center, Nebraska. Thirty-five thousand acres of land were turned over to the USDA in 1966, and Congress appropriated funds for the first phase of the building program. We are hoping the building plans will be finished by this fall and that we will be able to let contracts shortly thereafter. It will take a couple of years for construction. In the meantime, we are proceeding with the fencing, water supply, etc., essential for the handling of livestock. Cattle are being assembled and used in two experiments with low staff and facility requirements. These utilize the same cattle and are 1. a large-scale study of fertility and prenatal and postnatal mortality from Angus-Hereford crossbreeding, and 2. a study of between- and within-herd genetic variability. The latter involves use of semen from two bulls from each of eight herds in the Angus breed and the same for Polled Herefords.

Artificial insemination is being used and in a sense the two experiments represent a "shakedown cruise" on the use of AI on a large-scale in breeding experiments. I hope the work will give useful information and will also be helpful in guiding future operational procedures.

An Advisory Committee is being established for USMARC. We look forward to having USMARC research based on the best thinking both of people on our staff and of State Experiment Station personnel. We hope the program will make maximum use of a unique facility. It is going to take time to develop the facility and a program. It represents opportunity of a kind never available before in livestock research.

It is good to again have the opportunity of attending a W-1 meeting.

COMMENTS OF COOPERATIVE STATE RESEARCH SERVICE REPRESENTATIVE

(Dr. R. C. Carter of Virginia Polytechnic Institute had been asked to represent CSRS at the W-1 meeting.)

Dr. Carter:

I want to express my gratification at being here. I got a great deal out of the meeting. I have little to contribute from CSRS, I will make a report to them on the meeting.

My reaction has been that of a fellow worker from a state station rather than from the administrative standpoint.

Again, I am very happy to have been here.

COMMENTS OF ACTING INVESTIGATIONS LEADER

Mr. Knapp:

First, I would like personally to thank Dr. Brinks for his guidance and help.

All reports are in and we will get out the annual report as soon as possible.

You all received a list of publications. We have some extra copies. If you want any, please let us know. Also, if you find any corrections or additions to the list, please let us know.

Project revisions for next year are Arizona and Nevada. Colorado's project on serum lipids, Dr. Cramer's work, will terminate next year.

Thank you for working with us, each and every one of you.

TIME AND PLACE OF NEXT MEETING

Dr. Bogart moved that the committee continue rotation of the chairmanship, and that Dr. Christian be the next chairman. Dr. Bennett seconded. Motion carried.

The possibility of having an interregional meeting was discussed. Dr. Bogart moved that we go on record as favoring an interregional meeting next year or in the near future, subject to arrangements being made by representatives from the three regions. Dr. Bailey seconded. Motion carried.

If an interregional meeting was not to be held in 1968, it was considered desirable for W-1 to meet in Tucson. Dr. Roubicek said that April would be the best time to evaluate the cattle. A visit to San Carlos could be arranged at that time providing a full day was allowed for the trip. Mention was made of the fact that securing travel money in April might be difficult.

Dr. Holland moved that unless one station raised an objection from the standpoint of money for travel, the meeting would be held in Arizona next April in the event the interregional meeting is not held in 1968. Dr. Brinks seconded. Motion carried.

Dr. Bogart moved that in the event both ideas (the interregional meeting and meeting in Tucson in April) are unsuccessful, the planning of the next meeting of the W-1 Technical Committee in 1968 be left to the Executive Committee. Dr. Pahnish seconded. Motion carried.

The matter of all stations submitting reports in pounds or kilograms for the sake of uniformity was brought up.

Dr. Pahnish moved that for W-1 reports the English system be used. Dr. Rollins seconded. Motion carried.

Regarding possible programs for the next year, Dr. Holland expressed interest in a discussion on analysis and interpretation of data--discuss the history of the data, then the techniques of analysis. He also mentioned discussion of genetic trash.

Dr. Bogart moved that a committee of three be appointed to make a study of nutrition and feed efficiency and to follow through and make recommendations in a report at the next meeting. Dr. Brinks seconded. Motion carried.

Dr. Cobb called for the report of the Resolutions Committee.

RESOLUTIONS

WHEREAS members of the Division of Animal Science of the College of Agriculture of the University of Nevada, and particularly Dr. C. M. Bailey, have provided the members of the W-1 Technical Committee with excellent facilities and services, which have made our meeting effective, successful, and pleasant, therefore

BE IT RESOLVED, That the W-1 Technical Committee extend its thanks to the members of the Division through a letter to the Chairman of the Division with a copy to the Dean of Agriculture.

Motion was made by Dr. Blackwell, seconded by Dr. Bogart, that the resolution be adopted. Motion carried.

WHEREAS the Animal Husbandry Research Division of Agricultural Research Service is developing extensive research facilities at the United States Meat Animal Research Center, Clay Center, Nebraska, and

WHEREAS this Center has great potential for contributing to the successful solution of problems of meat production which affect the entire nation, and

WHEREAS we in the Western Region believe it is extremely important that planning and coordination of research activity at the U. S. Meat Animal Research Center be truly cooperative among the various regions of the United States, and that active participation in research which bears directly on beef cattle breeding problems in general is an essential prerequisite for developing the most effective research program to be carried out at the U. S. Meat Animal Research Center,

BE IT RESOLVED, That we make known to our Directors of state stations, to the Chief of Beef Cattle Breeding Research, to the Director of the U. S. Meat Animal Research Center, and to other administrators of Agricultural Research Service our desires to be actively involved in the decision-making process and in the carrying out of interregional research in which the U. S. Meat Animal Research Center is concerned.

Motion was made by Dr. Blackwell, seconded by Dr. Bennett, that

the resolution be adopted. Motion carried.

Resolutions committee:

Dr. L. A. Holland

Dr. J. S. Brinks

Dr. R. L. Blackwell, Chairman

BE IT RESOLVED, That appreciation be expressed to James S. Brinks for his services as Investigations Leader from 1964 through 1966. Our research was greatly strengthened by his wise counsel on design of experiments and analysis of data. His unfailing enthusiasm and optimism inspired us all to greater effort. We welcome him as the W-1 Technical Committeeman from Colorado.

Motion was made by Dr. Blackwell, seconded by Dr. Bogart, that the resolution be adopted. Motion carried.

Resolutions committee:

Dr. L. A. Holland

Dr. R. L. Blackwell, Chairman

ADJOURNED

